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ABSTRACT

Telecommunications infrastructure has the dual challenges of maintaining quality while accommodating change, issues that have long been met through a series of implementation standards. This document is designed to ensure that telecommunications systems within the Maryland public school system are also capable of meeting both challenges and incorporate those aspects of industry recognized standards which apply to school facilities. Sections of the document examine the quality assurance codes and standards for telecommunications systems installed in Maryland's public schools; address specific issues concerning the design of school buildings relating to integrating the telecommunications infrastructure; describes minimum requirements for cabling types, topologies, distribution, and installation; outlines additional requirements, recommendations, and planning considerations for dedicated broadband video distribution systems; and discusses the building of electrical systems that are designed to accommodate telecommunications. The final section presents a glossary of terms used in the document. Appendices present the minimum quantity of telecommunications outlets, a summary of the minimum telecommunications wiring standards, technology capabilities, and the standards-based infrastructure design. (Contains 23 references) (GR)

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ED 428 524

Maryland State Department of Education

# Maryland Public School

# Standards for Telecommunications Distribution Systems

Infrastructure Design for Voice, Video, and Data Communications

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1998

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# Maryland Public School

# Standards for Telecommunications Distribution Systems

Infrastructure Design for Voice, Video, and Data Communications

Division of Business Services
School Facilities Branch

Division of Instruction and Staff Development
Instructional Technology Unit

INITIAL ISSUE
1998

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January 1999



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# Foreword

For many years, the predominant building telecommunications technology was the telephone. Since its invention, over 100 years ago, the telephone has become a critical part of conducting everyday business worldwide. Despite the obvious value of the technology, it would not have become so successful if it were not also extremely reliable. In a way similar to the loss of basic electrical service, loss of "dial-tone" can spell disaster for organizations which rely on this essential utility. Loss of service, however, is rare, and when it occurs can be easily remedied, primarily because the entire telephone infrastructure is designed to a rigid set of industry-wide standards. These standards for telephone distribution systems, developed over many decades, are focused on perfecting the delivery of high quality (i.e., clear signal) service which is extremely reliable and which requires minimal maintenance to achieve these goals.

The advent of digital technology has taken the demand for reliability in telecommunications to a new level. The nature of this new technology is that it is much less "fault tolerant" than previous technologies. Degraded signals, which in past technologies resulted in weak, but perhaps acceptable reception to the end user, might result in complete system failure with digital technology. As technologies such as video, voice, and data delivery begin to merge, information transfer rates, and the resulting demand on the infrastructure, require rigid attention to the details of both design and installation. ***The first challenge of a building telecommunications infrastructure becomes one of quality. It must provide a high reliability of service by providing near-flawless delivery of signal throughout the network, over a long period of time, with virtually no maintenance. This is especially true for school facilities faced with unique challenges regarding the availability of trained personnel and limitations on the financial resources available for maintaining these increasingly complex systems.***

A second critical issue is the dynamic nature of both buildings and technology. Over the life of a facility, buildings are subject to both physical changes, and changes in the way that spaces are utilized. In addition, telecommunications technologies, and the needs of the building occupants in their application of these technologies, are subject to rapid change. ***Therefore, the second challenge of a telecommunications infrastructure is to recognize and accommodate change as a normal part of its function.***

Fortunately, the telecommunications industry has long recognized these issues and has developed a series of standards to guide the implementation of building telecommunications infrastructure. These standards, developed by national and international organizations such as the American National Standards Institute (ANSI), the Electronic Industry Association and the Telecommunications Industry Association (EIA/TIA), propose the development of structured cabling systems -infrastructures which conform to specific principles of organization and hierarchy and are constructed of components meeting rigid technical requirements. These systems, when designed and implemented correctly, provide predictable, measurable performance and can meet the challenges of reliability, low maintenance and adaptability.



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These Maryland Public School Standards for Telecommunications Distribution Systems are designed to ensure that telecommunications systems incorporated into our public schools are capable of accommodating changes to the building and in the use of technology, while delivering a high quality of service requiring minimum maintenance. This document incorporates those aspects of industry recognized standards which apply to school facilities, and provides additional guidelines or clarification where not otherwise provided. It fully supports the mandates of The Maryland Plan for Technology in Education, as they relate to school facility infrastructure and capabilities for technology.

This document is modular in format, resembling the industry-standard ANSI/EIA/TIA Telecommunications Building Wiring Standards. This format should allow for quick access to information by the user , and be familiar reading to those already versed in the referenced ANSI/EIA/TIA documents. This format should also allow for incremental revisions over time, as necessary. This standard will be updated by MSDE on a periodic basis as dictated by the requirements of changing technology, industry standards, and experience with actual installations. Users of this document are encouraged to submit their comments regarding the format or content to MSDE. Questions or comments can be addressed to the MSDE School Facilities Branch at (410) 767-0098.

SAB January, 1999

# Part 1- Introduction

## 1.1 Background

To ensure that Maryland students, teachers and administrators realize the benefits of new technology in education, a Blue Ribbon committee, formed by the State Superintendent of Schools and the Maryland Business Roundtable for Education, first met in 1992 to develop a vision for technology in Maryland education and a plan for implementation. Their findings became the basis for The Maryland Plan for Technology in Education, which was accepted by the State Board of Education in January, 1995. The plan served as an impetus and basis for program development and funding related to educational technology. In the spring of 1996, the Governor and Maryland General Assembly provided strong support for the implementation of technology in education by establishing Maryland Connected for Learning, a statewide effort to wire and provide equipment for all Maryland public schools.

The Fiscal Year 1997 budget submitted to the Maryland General Assembly included funding for a Technology in Maryland Schools (TIMS) program. The program was approved and included two parts: (1) funding in the Maryland State Department of Education budget for hardware, software, and school staff training, and (2) capital funding for wiring public schools (for data, voice and video) in the allocation of the Public School Construction Program. The program was envisioned as a multi-year effort. This initiative formally began on April 18, 1996 with a Request for Proposals briefing to the Local School Systems (LSSs).

In the Fall of 1995, in recognition of the need to establish minimum design criteria for school construction projects and in anticipation of this new TIMS program, the School Facilities and Instructional Technology staff of the Maryland State Department of Education began developing minimum standards for data, voice, and video distribution systems in school construction projects. During the standards development, several opportunities were provided for review and comment from technology and facility specialists in local school systems, several Maryland state agencies and universities, the Maryland business community, the U.S. Department of Education, and other state departments of education. The standards, when completed in early April 1996, applied to school construction projects that received approval by the Board of Public Works and school construction projects that were locally funded and required the approval of the State Superintendent of Schools. These original standards comprised two documents; the Maryland Public School Minimum Technology Capability Statements and Maryland Public School Standards for Information and Communications Distribution Systems.

In the Fall of 1997, a new committee was convened and charged with the task of reviewing and updating these original MSDE standards. These updates were to support the concurrent updating of The Maryland Plan for Technology in Education. This new committee was composed of a broad cross-section of representatives, knowledgeable in the subject matter, from Maryland State agencies, local school systems, universities, other state education agencies, industry standards organizations, and private industry, including engineers, architects, telecommunications industry consultants, manufacturers, installers, and major utility companies. This document, Maryland Public School Standards for Telecommunications Distribution Systems, is the result of this updating process. The content areas of both original standards have been consolidated into this single new document. This document supports those aspects of The Maryland Plan for Technology in Education: 1999-2003 that relate to school facilities infrastructure and technology capabilities.

## 1.2 Terminology and References

**A. Standard Terminology:** Terminology in this document is consistent with Electronic Industries Association/Telecommunications Industry Association (EIA/TIA) Standards documents, except where noted otherwise. Local School Systems and designers are strongly encouraged to conform to industry-standard terminology in all documentation pertaining to school facility telecommunications infrastructure including specifications, Requests for Proposals, drawings, etc.

**B. Mandatory Requirements:** Mandatory requirements are indicated by the use of wording such as "shall", "must be", "are to be", etc.

**C. Advisory Information:** Advisory information is also included in this document and is referenced by terminology such as "could", "may", and "recommended". Advisory information is included where there may be appreciable benefits to be achieved by exceeding the minimum standard, or where achieving compatibility with existing systems by relaxing the Standard may be required.

**D. References:** References to other documents in this Standard pertain to the latest available edition unless otherwise noted.

**E. Designer's Notes:**

> ***Designer's Notes:***
> *Highlighted in dialogue boxes such as this, Designers Notes are for informational purposes only. They are included to provide additional background information on the derivation of these standards and to assist in informed decision making.*

## 1.3 Intent of Standards

The intent of this document can be summarized as follows:

**A.** Establish minimum public school construction standards for voice, data, and video distribution systems which support The Maryland Plan for Technology in Education.

*Note: In order to ensure long-term usefulness of their telecommunications infrastructure, Local School Systems are encouraged to carefully analyze their requirements. Nothing in these Standards shall be interpreted as discouraging Local School Systems from exceeding these Standards where there is a determination of need, and adequate personnel and financial resources are available for installation and support of additional capability.*

**B.** Encourage the design of standards-based, structured cabling systems.

**C.** Emphasize the critical need for high quality in telecommunications system design and installation in order to reduce maintenance and provide reliable service over many years.

**D.** Encourage the use of widely recognized industry standards and terminology.

**E.** Support an open multi-product, multi-vendor environment.

**F.** Provide for flexibility and scalability, allowing options for site-specific requirements and the ability to change and upgrade systems in a modular fashion over time.

**G.** Provide a resource for knowledgeable local school system planners, educators and project designers planning and specifying telecommunications distribution systems for school construction projects. This document is not intended as an introductory document for those seeking to understand basic telecommunications system design.

## 1.4 Scope of Standards

**A. Overview:** This document establishes minimum criteria for the design and implementation of premises and campus telecommunications distribution systems, including the following elements:

- Campus Interbuilding Telecommunications Pathways and Spaces
- Intrabuilding Telecommunications Pathways and Spaces
- Specific Work Area Requirements
- Entrance Facilities
- Horizontal Cabling
- Campus Interbuilding Backbone Cabling
- Intrabuilding Backbone Cabling
- Telecommunications Outlets
- Telecommunications Closet Connecting Hardware
- Local Area Network Electronics (hubs, concentrators, and switches)
- Quality Assurance
- System Documentation

**B. Electrical Requirements:** It also establishes minimum criteria for building electrical power distribution required to support building telecommunications.

**C. References:** Refer to Parts 2 through 6 for specific items covered by this MSDE Standard.

**D. Items Not Included:** The following items are currently beyond the scope of this MSDE Standard, although this document does provide suggestions and recommendations for some of these items:

- Requirements for interbuilding cabling and equipment supporting Wide Area Network configurations which extend beyond the local Board of Education property line.

- Requirements for temporary facilities such as portable classrooms.
- Requirements for "plug-in" work-area devices (file servers, workstations, telephones, and associated *work area* patch cables, etc.).
- Requirements for telecommunications software.
- Standards for telecommunications services entering the facility which are provided by outside utilities or regulated by other authorities, (e.g., minimum quantity of telephone lines, Demarcation Point requirements, telephone switching equipment, minimum data transmission rates, service provider requirements, etc.).
- Requirements for paging or intercom system equipment.
- Requirements for dedicated Multi-media Interactive Distance Learning (MIDL) Facilities

# 1.5 Application of Standards

## 1.5.1 Application

**This MSDE Standard shall apply to the following types of school construction projects which have not been released for bidding prior to February 8, 1999:**

**A. State Funded Projects:**

***i.)*** All new school construction projects and major renovation projects funded through the Maryland Public School Construction Program (PSCP), which require planning approval by the Maryland Board of Public Works.

***ii.)*** These revised MSDE Standards also apply to all projects funded through Maryland's Technology in Maryland Schools (TIMS) initiative after FY 2000. These projects are also funded through the PSCP. Specific areas where deviations from these Standards may be considered for TIMS projects will be published with the TIMS Request for Proposal documents, or as an amendment to these Standards. Local School Systems are encouraged to follow these revised MSDE Standards for all TIMS projects through FY 2000 which are not yet under contract.

**B. Locally Funded Projects:** All locally funded new school construction projects and major renovation projects in excess of $350,000 in construction cost which require approval by the State Superintendent of Schools.

**C. Systemic Projects:** Systemic Renovation projects are defined in Section 400 of the PSCP Administrative Procedures Guide and generally refer to projects limited to the renovation of specific building systems such as roofing, HVAC, windows, etc. These standards would not typically apply to Systemic Renovation or even large "Multi-Systemic" projects unless these projects would effect some component of the Technology Infrastructure. For example, a large systemic renovation project to renovate a building's electrical system would be required to conform to **Part 6 - Building Electrical System.**

**D. Contact Information:** Questions regarding the applicability of these Standards to a specific project may be directed to the MSDE School Facilities Branch at (410) 767-0098.

## 1.5.2 Minor Interior Renovation and Addition Projects

**A. Definition:** Note that the term "major renovation" above generally applies to projects in which a substantial portion of the school facility or educational programs will be affected, or where it is reasonable to assume that the existing telecommunications systems will be discarded or substantially disturbed.

There are a number of project types which would not fall under this definition. Such projects include small classroom additions and interior renovation projects of limited scope such as Science Laboratory renovations. For these project types, it is reasonable to assume that the project budget would not support an upgrade to the entire building telecommunications system. Therefore, the applicability of these MSDE Standards to these projects shall be as follows:

**B. Requirements:** Standards-compliant telecommunications distribution systems shall be incorporated into all minor interior renovation and addition projects *to the maximum extent practical within the constraints of the project scope and budget and in accordance with sound principles of telecommunications distribution system design and facility planning.* Some flexibility may be allowed in tailoring the scope of work to the needs of the project. Allowances can be made for mitigating circumstances such as may be the case for particularly small projects, or for buildings which are scheduled to receive new telecommunications infrastructure in the near future. It is strongly

recommended that the LSS consider scheduling and coordinating these types of projects with whole-building wiring initiatives such as TIMS projects in order to achieve the most efficient and effective implementation of the telecommunications distribution system. Questions regarding applicability of these MSDE Standards should be directed to the appropriate School Facilities Specialist at MSDE. Except as described above, the following minimum requirements shall be met:

1. In existing school facilities in which the existing telecommunications distribution systems comply with these Standards, the new project shall also comply.

2. For minor interior renovation or small addition projects in existing school facilities which do not have existing telecommunications distribution systems supporting the area of work, the following requirements shall be met:

   ***i.)*** Within the area of work, new distribution system components shall be provided including, but not limited to, Telecommunications and Power Outlets, horizontal cabling, and pathway components such as conduit and raceway. These components shall be installed in full compliance with these MSDE Standards.

   ***ii.)*** All horizontal cabling shall be terminated in a horizontal cross-connect. This cross-connect and all associated hardware and electronics shall meet the requirements of **Part 4**. Connecting hardware and electronics shall have sufficient capacity to allow for activation of 100% of the new Telecommunications Outlets. The horizontal cross-connect shall be located in a Telecommunications Closet (TC) meeting the requirements of **Part 3.** (See **Part 3.6.1** for an exception allowing lockable cabinets in lieu of a TC for very small projects.

   ***iii.)*** In addition to the above, the new installation shall be provided with sufficient additional infrastructure to fully support the minimum requirements of the Maryland Plan for Technology in Education: 1999-2003. Specifically, new data outlets shall have sufficient supporting infrastructure to implement Local Area Network (LAN) networking between them, and INTERNET access. This may require the installation of distribution system components (such as backbone cabling) beyond the horizontal cross-connect. The most efficient and appropriate methods for achieving these requirements shall be at the discretion of the LSS but should comply with the requirements of this MSDE Standard in accordance with **Item B: Requirements** above.

3. For minor interior renovation or small addition projects in existing school facilities which have existing telecommunications distribution systems which do not comply with these MSDE Standards, the provisions of **Item B-2** above shall be met. Existing non-compliant components serving the area of work, from the Telecommunications Outlets to, and including, the cross-connect (including connecting hardware and electronics) shall be removed or abandoned. Where the existing TC is not in compliance with these MSDE Standards, the TC shall be renovated, or a new TC shall be provided (**See Part 3.6.1** for an exception allowing lockable cabinets in lieu of a TC for extremely small projects).

   *Exception: Existing Category 5 UTP horizontal cabling which has been tested to ensure that performance meets the minimum worst-case channel performance recommendations of TIA PN-4292 (proposed EIA/TIA Telecommunications Systems Bulletin TSB 95) shall not require replacement. Some additional exceptions may be allowed in accordance with 1.5.2 B above.*

> ***Designer's Note:***
> *Proposed TSB 95 (scheduled for final publication in early 1999) specifies new criteria for Category 5 cabling (ELFEXT, PowerSum ELFEXT and Return Loss). It is to be used for specifying the worst-case channel performance of installed or "legacy" Category 5 cabling. Systems passing this test will be able to support future Gigabit Ethernet.*

**C. Contact:** Questions regarding the applicability of these Standards to a specific project may be directed to the MSDE School Facilities Branch at (410) 767-0098.

# Part 2- Quality Assurance

## 2.1 Codes

**A.** All Telecommunications Distribution Systems installed in Maryland's Public Schools shall be designed and installed in strict conformance with applicable Federal, State, and Local codes and law. *Nothing in this document shall be interpreted as recommending or approving a lower standard than applicable statutory requirements.*

**B.** The following list of Codes are provided for reference only. The codes which apply to an specific project should be verified during the design process. See the **References** section for information on obtaining these documents.

**Maryland Building Performance Standards (MBPS)** - The MBPS incorporates the following Model Building Codes, with State and local amendments, and will be enforced throughout all of Maryland by August 1, 1999:

BOCA National Building Code
NFPA 101

**NFPA 70** - National Electrical Code (NEC)

**Code of Maryland Regulations (COMAR) 05.02.02** - Maryland Accessibility Code

**ADA** - The Americans with Disabilities Act, particularly the ADA Accessibility Guidelines**(ADAAG).**

**FCC 47 CFR 68 and 15 -** The Code of Federal Regulations (FCC regulations regarding broadband video distribution)

## 2.2 Standards

**A. Standards:** The recommendations of the most recent version of the following documents, including all supplements, annexes, addenda and revisions, shall be incorporated into telecommunications distribution systems which fall under the jurisdiction of this MSDE Standard. Where this MSDE Standard omits items included in the following documents, the industry standard recommendations shall be incorporated, where applicable. Where this MSDE Standard revises the following documents, this MSDE Standard shall take precedence. See the **References** section for information on obtaining these documents.

| | |
|---|---|
| **TIA/EIA-568A** | *Commercial Building Telecommunications Cabling Standard* |
| **TIA/EIA-569A** | *Commercial Building Standard for Telecommunications Pathways and Spaces* |
| **TIA/EIA-606** | *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings* |
| **TIA/EIA-607** | *Commercial Building Grounding and Bonding Requirements for Telecommunications* |
| **TIA/EIA TSB 67** | *Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems* |
| **TIA/EIA TSB 72** | *Technical Services Bulletin - Centralized Optical Fiber Cabling Guidelines* |
| **TIA/EIA TSB 75** | *Technical Systems Bulletin - Additional Horizontal Cabling Practices for Open Offices* |
| **IEEE 802.3** | *CSMA/CD Access Method* - Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications. (Ethernet Protocols). |
| **IEEE 802.7** | *Recommended Practices for Broadband Local Area Networks* |
| **IEEE 802.11** | *IEEE Standard for Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications* |
| **IEEE 1100-199** | *Recommended Practice for Powering and Grounding Sensitive Electronic Equipment* |

## 2.3 Designer and Installer Qualifications

**A. Overview:** In ensuring the long-term appropriateness, effectiveness, and reliability of telecommunications systems incorporated into Maryland's Public Schools, both designers and installers play a crucial role. It is the role of the designer to ensure that the project specifications reflect an educationally and technologically appropriate, cost-effective solution to telecommunications distribution which will serve the long-term needs of the school system. At a minimum, it is the role of the installer to ensure that the system is installed in a manner that ensures optimum system performance, reliability and ease of maintenance, and that this work is accurately documented.

**B. Minimum Qualifications:** LSSs shall adopt minimum qualifications criteria for all Designers and Installers. For each project, designers and installers shall provide clear evidence of qualifications to ensure conformance with LSS requirements. Qualifications criteria shall be as determined by the LSS as required to meet local need and as required to ensure conformance with local and/or State procurement practices and/or existing contracts. *The following minimum qualifications requirements are strongly recommended, but are not mandated by this MSDE Standard.*

**C. Design Consultant Qualifications:** This section provides qualifications recommendations for companies providing consulting services for the production of project specifications and other construction contract documents and/or technical support for creating Requests for Proposals. Documentation of the following qualifications information is recommended:

*i.)* **Company Experience:** Successful prior experience with a minimum of three (3) recent projects *which are similar in size, complexity (including schedule constraints) and scope* should be documented in detail. Provide names and contact information for prior customers. Letters of recommendation are desirable. Indicate which of the installers current key staff were involved in these projects and their roles. Provide detailed information on the scope of these prior projects, obstacles which were overcome and any other relevant criteria. Documentation of the consultants office work-load at the time of execution of the contract should be provided. Demonstrate an understanding of EIA/TIA, other relevant industry standards, and MSDE and Local School System standards.

*ii.)* **Staff Experience:** Detailed information should be provided on the experience and training of all key members of the project team (project manager, project designer, etc.). Criteria similar to (i.) above should be applied. A description of each key team members role in the project should be provided. Documentation of formal training and experience in telecommunications system design should be provided, particularly in high bandwidth channel ACR applications. For data systems, it is recommended that at least one key team member hold a BICSI Registered Communications Distribution Designer (RCDD) certification, preferably with a LAN Specialty designation, or provide evidence of other similar training and relevant experience. For video systems, a thorough knowledge of NTSC, FCC, TIA, and BICSI standards and guidelines should be demonstrated.

***iii.)*** **Project Understanding:** The Designer should be able to demonstrate a thorough understanding of the project type, and be able to discuss project specifics such as the range of alternatives available, their strengths and weaknesses, impact on performance, scalability, ease-of-use, cost, schedule, maintenance, and reliability.

***iv.)*** **Insurance:** Evidence that the consultant has sufficient professional liability insurance coverage as required by local procurement requirements. Documentation of prior insurance claims record is desirable.

***v.)*** **Industry Commitment:** Evidence of company and key personnel commitment to the industry, and to continuing education, is desirable. This could be demonstrated through active membership in industry organizations such as BICSI, IEEE, ANSI, and EIA, or participation in manufacturer certification programs.

***vi.)*** **Additional Information:** Provide any other relevant information which demonstrates an understanding of the project and an ability to successfully install high-quality telecommunications systems in a school environment.

**D. Installer Qualifications:** This section provides qualifications recommendations for installation-only companies and also turn-key companies which provide both design and installation services. Documentation of the following qualifications information is recommended:

***i.)*** **Company Experience:** Successful prior experience with a minimum of three (3) recent projects *which are similar in size, complexity (including schedule constraints) and scope* should be documented in detail. Provide names and contact information for prior customers. Letters of recommendation are desirable. Indicate if the installer was a prime or subcontractor. Indicate which of the installers current key staff were involved in these projects and their roles. Provide detailed information on the scope of these prior projects, obstacles which were overcome and any other relevant criteria. Documentation of the installers total work-load at the time of execution of the contract should be provided, to ensure that sufficient resources are available. Demonstrate an understanding of EIA/TIA and other relevant industry standards, and MSDE and LSS standards.

***ii.)*** **Staff Experience:** Detailed information should be provided on the experience and training of all key members of the project team (project manager, designer, integration engineer, foreman, etc.). Criteria similar to (i.) above should be applied. A description of each key team members role in the project should be provided. Documentation of formal training and experience in telecommunications system design and installation should be provided. At least one key team member should demonstrate formal training beyond manufacturers certification programs in high bandwidth channel ACR requirements. For data systems, it is strongly recommended that at least one key team member hold a BICSI Registered Communications Distribution Designer (RCDD) certification, preferably with a LAN Specialty designation. For video systems, a thorough knowledge of NTSC, FCC, TIA, and BICSI standards and guidelines should be demonstrated.

***iii.)*** **Project Understanding:** The Installer should be able to demonstrate a thorough understanding of the project type, and be able to discuss project specifics such as the range of alternatives available, costs, installation issues, project constraints, and schedule impact.

***iv.)*** **Manufacturers Certifications:** Detailed evidence that the installer has successfully completed manufacturers training and certification programs for both installation and maintenance of the systems which were specified, including refresher and/or continuing education courses. Note: Long-term (i.e., 15 year plus) performance warranties tend to require the highest standard of manufacturer training. Training for certification should include 1) installation and connectorization, 2) certification and troubleshooting, and 3) standards-based design.

***v.)*** **Warranty:** Provide information on warranty validation and support, including evidence that the installer is certified by the system manufacturer under the terms of the project warranties.

***vi.)*** **Bonding and Insurance:** Evidence that the installer has sufficient bonding and insurance capacity as required by Local and State procurement requirements. Documentation of prior insurance claims record is desirable.

***vii.)*** **Industry Commitment:** Provide evidence of company and key personnel commitment to the industry, and to continuing education, is desirable. This could be demonstrated through active membership in industry organizations such as BICSI or other relevant affiliations.

***viii.)*** **Additional Information:** Provide any other relevant information which demonstrates an understanding of the project and an ability to successfully install high-quality telecommunications systems in a school environment.

## 2.4 School System Training Requirements

**A. Training Requirements:** Project specifications shall include a school system staff training provision for all telecommunications installation contracts. After distribution systems have been tested and accepted the installation contractor and/or the manufacturer's designated representative shall provide training for key school system staff. Training shall thoroughly cover the main features of system operations and maintenance and a review of all system documentation and warranty requirements. A sufficient number of training hours and/or sessions shall be specified to ensure adequate training.

**B. Training Recommendations:** The dynamic nature of the telecommunications industry, the merging of multiple technologies, and the ever-increasing utilization of these technologies in the educational environment, place particular demands on school system personnel responsible for the technical aspects of technology implementation. In addition to being conversant on the many possible uses of educational technology within the classroom, they are also required to be knowledgeable in a myriad of technical details, from funding sources to wiring specifications. The Maryland Plan for Technology in Education 1999-2003 recognizes the need for staff development in this area and provides recommendations for addressing this issue.

As school systems begin to address staff training, it is important to not overlook specialized training in distribution system design as an important component. It is recommended that the appropriate personnel be provided with access to specialized training opportunities in telecommunications distribution design. Training opportunities through several State and national organizations are available. BICSI in particular offers a comprehensive training program which can lead to internationally recognized certification in several areas of telecommunications design. Staff for several LSSs in Maryland have already obtained, or are in the process of obtaining, BICSI RCDD certification. In addition, membership in organizations such as BICSI can be an effective way of keeping abreast of industry trends on the technical implementation of telecommunications technology.

## 2.5 Industry Resources

**A. BICSI Publications:** Quickly becoming an international standard, the publications produced by BICSI can prove particularly valuable for checking the appropriateness and quality of a telecommunications distribution installation. Two especially useful documents are the BICSI Telecommunications Distribution Methods Manual (TDMM) and the BICSI LAN Manual. The degree of familiarity with these documents can help to demonstrate the experience and qualifications of a particular designer or installer. Training programs for Registered Communications Distribution Designer (RCDD) and other certifications are based on these documents. While not a replacement for the EIA/TIA standards, they can be an excellent supplement, providing details on the "nuts and bolts" of system planning and installation. See **References** for information on obtaining these documents.

Several LSSs cross-reference the BICSI publications in their standard telecommunications specifications. Where BICSI standards are incorporated into project specifications, the requirements of this MSDE standard and the ANSI/EIA/TIA standards shall take precedent.

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# Part 3 - Telecommunications Pathways and Spaces

## 3.1 Planning Considerations

### 3.1.1 Overview

This Section addresses specific issues concerning the design of school buildings as it relates to correctly integrating the telecommunications infrastructure in a way that will ensure both high reliability and adaptability for future needs. **See 1.5** for applicability of these requirements.

### 3.1.2 Facilities Planning

To ensure that telecommunications technology is correctly incorporated into the constructed facility, ***it is crucial that planning for the telecommunications infrastructure begins at the earliest stages of school facility planning***. The following decision deadlines are recommended:

**Educational Specifications:** Minimum expectations for access to technology for each type of space should be established. Indicate minimum number of Telecommunications Outlets, the type of technology resources that should be available, and any special requirements. Indicate the preferred location for the Telecommunications Equipment Room, its anticipated functions, and minimum area to be used for preliminary planning.

**Schematic Design:** Finalize the size and location for the Telecommunications Equipment Room. Provide preliminary recommendations for the locations of the Telecommunications Closets.

**Design Development:** Finalize major decisions on the type and methodology of cabling distribution early in the Design Development phase, so that all elements can be coordinated with other disciplines.

**Construction Documents:** Finalize and verify the type and exact location of Telecommunications Outlets. Complete project Construction Documents (drawings and specifications). Provide a thorough Quality Assurance check of the entire telecommunications distribution system before bidding and construction.

### 3.1.3 Standards

Standards for the installation of Telecommunications Pathways and Spaces are described in ANSI/EIA/TIA-569, the most current version of which shall act as the final arbiter in answering questions concerning this Part of the MSDE Standards. The following sections summarize some more salient issues often encountered in school facilities. In some areas, this Standard may identify allowable deviations from ANSI/EIA/TIA-569, or provide specific provisions for school facilities not otherwise addressed.

## 3.2 Horizontal Pathways

### 3.2.1 General Requirements for Horizontal Pathways

**A. Application:** All school facilities which fall under the jurisdiction of this Standard shall have Horizontal Pathways designed and installed in conformance with ANSI/EIA/TIA-569, except as otherwise noted. The following General Requirements address items typically encountered in school projects.

**B. Definition:** Horizontal Pathways are those building components that provide for the installation of cabling media between the work area Telecommunications Outlets and the Telecommunications Closets. A single school facility may have one or a combination of several types of pathway strategies, depending on many factors such as cabling type and quantity, construction type of building, building codes, flexibility and cost. Typical Horizontal Pathway components and strategies include underfloor duct and raceway systems, cellular floor systems, access floor, conduit, cable trays, wireways, utility columns, ceiling distribution systems and perimeter pathway systems such as surface, molding, or recessed raceways. All these systems are discussed in detail in the referenced ANSI/EIA/TIA standard.

**C. Codes:** Close attention should be paid to applicable building and electrical codes, which prescribe, among other issues, acceptable locations for telecommunications pathways, restrictions on penetrations through fire-rated construction assemblies, and restrictions on telecommunications pathways through air plenums.

## 3.2.2 Design Considerations for Horizontal Pathways

**A. Elevator Shafts:** Horizontal pathways shall not pass through elevator shafts and machine rooms. This does not preclude the installation of telecommunications wiring provided for the elevator system and which is installed in accordance with applicable codes. Horizontal Pathways shall not pass through fire rated exit stair enclosures.

**B. Dry Locations:** Intrabuilding Horizontal Pathways shall be installed in "dry" locations only. Horizontal Pathways shall not be located underground or in concrete "slab-on-grade" installations.

**C. Bonding and Grounding:** Bonding and Grounding of Horizontal Pathways shall be in accordance with applicable electrical codes and ANSI/EIA/TIA-568A. **See Parts 4.3, 4.4, and Part 6.**

**D. Firestopping:** All pathway penetrations through fire-rated construction assemblies are to be firestopped in accordance with applicable codes. **See 3.7.**

**E. Exposed Cabling:** In no case shall telecommunications infrastructure cabling be run exposed in any room, except for Telecommunications Closets and Equipment Rooms.

## 3.2.3 Electromagnetic Interference

**A. Electromagnetic Interference (EMI):** Horizontal pathways shall not be located close to sources of high levels of EMI, such as fluoresent lighting fixtures, photocopy machines, transformers and motors utilized in the building mechanical systems. **See Figure 3-1 below.**

**Figure 3-1**

Minimum Pathway Separation from E.M.I Sources*

| | |
|---|---|
| Flouresent Lighting | 12 inches |
| Neon Lighting | 12 inches |
| Unshielded Power Cable | |
| 2 KVA or less | 5 inches |
| Over 2 KVA | 39 inches |
| Transformers/Motors/HVAC Fans | 39 inches |

(*) separation distances not mandatory for horizontal fiber-optic pathways

## 3.2.4 Conduit

**A. Conduit Requirements:**

*i.)* At a minimum, conduit or other enclosed pathways such as surface mounted raceways or utility columns, are to be provided from all Telecommunications Outlets to the ceiling distribution system.

*ii.)* Conduit, or other approved pathways are to be utilized where required by applicable electrical codes. This may include special requirements for pathways installed in mechanical rooms and through air plenum spaces. Refer to ANSI/NFPA 70 *National Electrical Code* (NEC).

*iii.)* Conduit shall be sized in accordance with the requirements of applicable codes. The maximum number of cables for a given conduit size shall not exceed those listed in Table 4.4-1 of the referenced ANSI/EIA/TIA Standard.

*iv.)* Conduit shall extend a minimum of 3" above finished floor where penetrating through the floor into a Telecommunications Closet or Telecommunications Equipment Room.

*v.)* Conduit runs shall contain no more than two (2) 90° bends between pull points. A pull box shall be installed at all "U" bends.

## 3.2.5 Cable Trays and Wireways

**A. Cable Tray and Wireway Requirements:**

*i.)* The overall fill ratio of any cable tray or wireway shall not exceed 50%.

*ii.)* Supports shall be at 60" on center maximum, unless engineered for greater spans. Supports shall be provided within two (2) feet on each side of fittings such as tees, elbows reducers, etc.

*iii.)* Access to cable trays shall not be restrcted by other building components. A minimum of 12 inches of clear space shall be provided above cable trays for installation and maintenance access.

*iv.)* Cable trays shall extend a minimum of three (3) inches through wall penetrations before any bends.

### 3.2.6 Ceiling Distribution

**A. Ceiling Distribution Requirements:**

***i.)*** Refer to applicable building and electrical codes for regulations governing cabling installation in ceiling spaces, including air plenums. Provide conduit or other raceways where required.

***ii.)*** Ceilings used for horizontal pathways must be accesible. Ceilings constructed of suspended gypsum wallboard, lock-in ceiling tiles or other non-accesssible materials shall not be utilized for horizontal pathways.

***iii.)*** Cable shall not be laid directly on ceiling tiles or suspension members. A minimum of three (3) inches shall be provided above ceiling support members for cable pathways. Cable pathways shall not interefere with the ability to remove and install ceiling tiles.

***iv.)*** Where conduit, cable trays or other raceways are not provided, provide open-top ("J-hook") cable supports at 48-60" on center maximum. Where a large number of bunched conduits require support, (e.g., near a Telecommunications Closet), provide supports capable of supporting the concentrated load. As an alternate to J-hooks, ceiling support wires may be utilized, if the additional weight of cable does not exceed the design capacity of the suspension system. This approach is not encouraged in school construction, and should be used judiciously.

## 3.3 Intrabuilding Backbone Pathways

### 3.3.1 General Requirements for Intrabuilding Backbone Pathways

**A. Application:** All school facilities which fall under the jurisdiction of this Standard shall have Interbuilding Backbone Pathways designed and installed in conformance with ANSI/EIA/TIA-569, except as otherwise noted below.

**B. Definition:** Backbone pathways are those building components which provide for the installation of backbone cabling. Backbone pathways include inter and intrabuilding pathways. *Intrabuilding* Backbone Pathways extend between the Entrance Facility, Telecommunications Closets and the Telecommunications Equipment Room within the same building. Within a single building, Backbone Pathways may be horizontal and/or vertical. *Interbuilding* Backbone Pathways, for purposes of this MSDE Standard, extend between buildings on the same Board of Education owned property **(See 3.4).** Backbone Pathways are discussed in Part 5 of the referenced ANSI/EIA/TIA standard. The following requirements address issues typically encountered in school projects.

**C. Codes:** Close attention shall be paid to applicable building and electrical codes, which prescribe, among other issues, acceptable locations for telecommunications pathways, restrictions on penetrations through fire-rated construction assemblies, and restrictions on telecommunications pathways through air plenums.

## 3.3.2 Design Considerations for Intrabuilding Pathways

**A. Acceptable Components:** Backbone pathways for all school construction projects must provide support and protection for the backbone cabling for the entire length of the cable run, from the Telecommunications Closets to the Telecommunications Equipment Room. The preferred methods of Backbone Distribution are cable trays or lay-in wireways. Ridgid conduit is also acceptable, but may limit the adaptability of the infrastructure, and should only be utilized where required by applicable codes or where maximum flexibility is not required. Non-metallic Innerduct, (or subduct), may be used within these components to facilitate installation of cabling. Pathway components which do not provide continuous support, such as open-topped cable supports, ("J-hooks"), are not acceptable for Backbone Pathways, except for optical-fiber backbone distributed in innerduct where supported at 48" on center maximum.

**B. Cabling Requirements:** Backbone pathways shall be capable of accomodating all telecommunications media recognized in ANSI/EIA/TIA-568A, including 100 Ohm Unshielded Twisted Pair (UTP), 62.5/125µm optical-fiber, single-mode optical-fiber cable and 50 Ohm coaxial cable. Particular attention should be paid to limitations on bending radius for all cable types.

**C. Capacity:** Pathways shall be sized to accomodate the anticipated size, type, and quantity of cables, and provide capacity for future growth. Provide additional empty conduits, trays, sleeves, etc., where as may be necessary to add additional capacity without causing significant disruption to the facility.

**D. Elevator Shafts:** Backbone pathways shall not pass through elevator shafts and machine rooms. This does not preclude the installation of telecommunications wiring provided for the elevator system and which is installed in accordance with applicable codes. Horizontal Pathways shall not pass through fire rated exit stair enclosures.

**E. Bonding and Grounding:** Bonding and Grounding of Backbone Pathways shall be in accordance with applicable electrical codes and ANSI/EIA/TIA-568A. **(See Part 6.10.)**

**F. Dry Locations:** Intrabuilding Backbone Pathways shall be installed in "dry" locations only. Horizontal Pathways shall not be located underground or in concrete "slab-on grade" installations.

**G. Firestopping:** All pathway penetrations through fire-rated construction assemblies are to be firestopped in accordance with applicable codes. **See 3.7.**

## 3.3.3 Conduit

**A. Conduit Requirements:**

***i.)*** Conduit, or other approved pathways are to be utilized where required by applicable electrical codes. This may include requirements for pathways installed in mechanical rooms and through air plenum spaces. Refer to ANSI/NFPA 70 *National Electrical Code* (NEC).

***ii.)*** Conduit shall be sized in accordance with the requirements of applicable codes. The maximum number of cables for a given conduit size shall not exceed those listed in Table 5.2-1 of the referenced ANSI/EIA/TIA Standard.

***iii.)*** Conduit shall extend a minimum of 3" above finished floor where penetrating through the floor into a Telecommunications Closet or Telecommunications Equipment Room.

***iv.)*** Conduit runs shall contain no more than two (2) 90° bends between pull points. A pull box shall be installed at all "U" bends.

### 3.3.4 Cable Trays and Wireways

**A. Cable Tray and Wireway Requirements:** The installation of cable trays and wireways utilized for Intrabuilding Backbone Pathways shall comply with **3.2.5.**

## 3.4 Interbuilding Backbone Pathways

### 3.4.1 General Requirements for Interbuilding Pathways

**A. Application:** All school facilities which fall under the jurisdiction of this Standard shall have Horizontal Pathways designed and installed in conformance with ANSI/EIA/TIA-569, except as otherwise noted.

**B. Industry Standards:** Interbuilding Backbone Pathways shall be installed in conformance with Annex C of ANSI/EIA/TIA-569A, (February, 1998) unless noted otherwise. (It is anticipated that this Annex will be issued as a separate ANSI/EIA/TIA Standard in the near future). Note that these industry standards are much more comprehensive in scope than may be required for most typical public school facilities.

**C. General Methods:** Methods of providing Interbuilding Pathways identified in the Industry Standards include underground, buried, aerial, and tunnel installations. Direct Burial methods are not recommended for school facilities. Tunnel systems are expensive, and usually reserved for large "campus" type installations not usually found with public schools. The following is a review of requirements which may typically be encountered by school facilities serving a satellite building on the same property with underground or aerial pathways.

**D. Conduit Types:** Requirements for underground installation of conduits and ducts are found in the applicable codes, including requirements for minimum depth, support, capacity, continuity and grounding, and end protection. Acceptable conduit types include:

Polyvinyl Chloride (PVC) Type B - concrete encasement required
PVC Type C - for direct burial
Multiple Plastic Duct (MPD) - for direct burial
Steel - Ridgid Steel conduit with galvanized coating
Fiberglass
Innerduct (subduct), shall not be directly buried, but can be used within one of the pathway types listed above, where required to facilitate cable separation and installation.

**E. Conduit Quantity and Sizing:** Interbuilding conduit systems usually consist of several (4) trade size conduits, for use with larger diameter multi-pair copper cabling, or several (2) trade size conduits for use with fiber optic, CATV or other small diameter cable. Innerduct can be installed within (4) trade size conduit for placement of small diameter cabling, or to facilitate future cabling installation.

Spare conduit capacity shall be provided equal to 50% over the initial installation, by providing oversized or additional conduit. Pull strings or rope shall be provided in all empty conduits.

**F. Routing:** Route pathways to minimize bends. Provide handholes, maintenance holes, pull and splice boxes where required.

**G. Lightning Protection:** Note that interbuilding pathways intended for the use of copper cabling may require lightning protection per Article 780 of the NFPA Lightning Protection Code.

## 3.5 Telecommunications Equipment Room (TER)

### 3.5.1 General Requirements

**A. Application:** All school facilities which fall under the jurisdiction of this document shall be required to have a Telecommunications Equipment Room (TER) meeting the following criteria. In campus situations where more than one school building is located on one property, a single TER may serve the needs of the entire campus.

**B. Definition:** The TER is a secure, climate controlled space dedicated for the exclusive use of the Building Telecommunications Systems. It shall typically house the Entrance Facilities and Demarcation Points for the various telecommunications systems serving the building, and the central distribution equipment for these systems (e.g., Main Distribution Frames, Video Switch, PBX, etc.,).

In smaller facilities the TER may serve as the main termination point for all horizontal cabling. In larger facilities which require the addition of Telecommunications Closets, it serves as the termination point for the building Backbone Distribution system, and may also serve as the termination point for horizontal cabling for a portion of the building.

The TER is the recommended location for the main building file servers and for files containing as-built documents, manufacturers data sheets and other system documentation which are necessary for quick response when maintaining and troubleshooting systems.

***Designer's Notes:***
*1. An adequately sized and designed TER is crucial to the long-term reliability, operations and maintenance of the building telecommunications systems. Due attention shall be paid to the requirements indicated below in order to ensure adequate accommodation of telecommunications equipment, including future system modifications.*

*2. The preferred location for Entrance Facilities is the TER. However, statutory requirements governing local utilities may require alternate locations in some circumstances. Entrance Facilities shall comply with the requirements of TIA/EIA -569 and local utility requirements. Designers shall coordinate design requirements with the serving utilities.*

## 3.5.2 Standards

Equipment Rooms shall be designed in accordance with ANSI/TIA/EIA-569, Part 4. Some of these requirements are presented in summary form below. Where these Standards differ from the referenced document, these Standards are to take precedent.

## 3.5.3 Architectural Requirements:

**A. Location:** Consideration shall be given to the following when locating the TER:

*i.)* **Media Center:** Careful consideration shall be given to adjacencies with other related spaces and the management of the telecommunications system when locating the TER. It is *strongly recommended* that the TER be located adjacent to, or become an integral part of, the Library Media Center. This allows the building file servers holding instructional software, and other centralized media sources such as CD-ROM towers to be in a location where they can be continuously monitored and supervised by the Media Specialist. Often a small office or workroom is provided adjacent to the TER, designed for the use of the school Technology specialist, where one is provided.

*Exception for small buildings:* A possible exception to the Media Center location (if acceptable to the school design committee), is to locate the TER in a central location (where all horizontal cabling distances are less than 295 feet) so as to eliminate the need for additional telecommunications closets and the associated expense of fiber-optic backbone and electronics.

***Designer's Note:***
*The TER presents an excellent design opportunity for emphasizing the important role of Technology within the school. For example, the TER could be designed with windows for visual access from the adjacent corridors or the Media Center (where allowed by code).*

***ii.)*** **Future Expansion:** Avoid locations that can limit future expansion of the space, such as adjacent to core facilities such as stair enclosures, elevator shafts, outside walls, etc.

***iii.)*** **Cabling Limitations:** Locate the TER as required by the limitations of the cabling infrastructure. The TER shall be located adjacent to the backbone pathway (typically a corridor).

***iv.)*** **Water:** Avoid locations in proximity to water pipes and below lavatory facilities.

***v.)*** **Corridor Access:** The TER shall be accessible from a corridor to the greatest extent possible. Accessibility for after-hours maintenance is critical.

***vi.)*** **Vibration:** The TER shall be isolated from sources of mechanical vibration.

***vii.)*** **E.M.I.:** The TER shall be located away from sources of EMI, such as electrical power supply transformers, motors, generators, and radio transmitters. Photocopy equipment should not be located within ten (10) feet of a TER.

**B. Area Requirements:** Area requirements will vary, depending on room configuration, type and amount of equipment and room usage. Size requirements shall include projected future, as well as known present requirements. The following standards outlined in **Figure 3-2** establish ***minimum*** requirements only, and shall be verified for adequacy for each project.

**Figure 3-2**
Minimum Area Requirements for Telecom Equipment Rooms

| | |
|---|---|
| Very small schools (<200 students): | 100 net square feet |
| Elementary Schools (up to 500 student capacity): | 120 net square feet |
| Elementary Schools (up to 750 student capacity): | 150 net square feet |
| Elementary Schools (over 750 students capacity): | 200 net square feet |
| Middle Schools (up to 750 students) | 150 net square feet |
| Middle Schools (up to 1,000 students) | 200 net square feet |
| Middle Schools (over 1,000 students) | 250 net square feet |
| High Schools (up to 1,400 students) | 300 net square feet |
| High Schools (over 1,400 students) | 350 net square feet |
| High Schools (over 1,750 students) | 400 net square feet |

*Combined Schools shall use the minimum requirements for the highest grade level served*

**C. Ceiling Height:** There shall be a minimum clear ceiling height of eight feet.

**D. Floor Loading:** Adequate design capacity for floor loading shall be calculated by the building design professional, taking into consideration the proposed equipment weights and layout (including projected future needs), and applicable building code requirements.

***Designer's Note:***
*ANSI/EIA/TIA-569 recommends a minimum floor loading capacity of 100 lbf/ft² and a minimum concentrated load rating of 2,000 lbf. These capacities shall be verified as indicated.*

**E. Finishes:**

***i.)* Cleanability:** Finishes should be smooth and sealed to prevent production and accumulation of dust.

***ii.)* Colors:** Light colors are recommended to enhance room lighting and facilitate maintenance.

*iii.)* **Acoustical Ceilings:** Where acoustical ceiling tile is utilized, consider the use of vinyl or foil-faced products designed for clean environments. Where factory-sealed edges are disturbed by field cutting, apply foil or vinyl tape to reseal edges, per manufacturers recommendations.

*iv.)* **Floor Coverings:** Floor coverings shall have anti-static properties. Well-sealed concrete is economical, and may be superior to many other materials in anti-static performance. Some Vinyl Composite Tile (VCT) and sheet goods are also acceptable.

*v.)* **Plywood:** Provide a covering of painted 3/4" A-C plywood, void free, on at least two walls of the TER capable of supporting wall-mounted equipment. Fire safety officials will often not allow fire-retardant treated plywood to be painted. Therefore, the recommendation is to use standard plywood and finish with a fire-retardant paint after installation. Verify local requirements. Pressure treated plywood shall not be used.

**F. Door(s):** Provide a minimum of one (1) 36 inch wide entrance door. Where large equipment is anticipated, consider a 48" door, a 36" door with side panels, or double doors. Center mullions, where required, should be removable. Doors shall be provided with heavy-duty locks.

## 3.5.4 Mechanical Requirements

**A. HVAC:** An environmentally controlled atmosphere is required, 24 hours per day, 365 days per year. This is critical to protect the substantial investment in equipment represented in the TER. If a standby power source is available, consideration shall be given to connecting the HVAC equipment serving this space to the standby power system.

**B. Temperature/Humidity:** The ambient room temperature in the TER must be maintained between 60 and 80 degrees Fahrenheit, with a relative humidity of 30% to 60%, both measured at a distance of five feet above the finished floor along the equipment aisle centerline with all equipment running. Cooling systems must accommodate a minimum of 50 watts/square foot of heat load generation from active equipment, or as determined by the project designer based on an internal heat load assumption derived from an analysis of the proposed equipment (present and projected future) for the specific project.

**C. Positive Pressure:** The TER must be maintained under positive pressure relative to adjacent spaces.

**D. Ventilation:** Provide adequate ventilation, in accordance with applicable electrical codes, where batteries are provided for back-up power.

**E. Fire Protection:** Provide fire protection systems, where required by, and in conformance with applicable code.

If sprinklers are required, provide sprinkler head protection such as wire baskets to prevent accidental discharge. Provide troughs or other protection to protect equipment from accidental leakage. Configure piping so as to require the fewest number of sprinkler heads and fittings. In some facilities, it may be worthwhile to consider alternate fire suppression systems.

Provide a wall mounted portable fire extinguisher, mounted adjacent to the latch side of the main exit door, and rated for electrical fires in accordance with applicable codes. The room envelope (walls, ceiling, doors) shall be fire-rated where required by, and in conformance with, applicable building codes. All penetrations shall be fire stopped.

## 3.5.5 Electrical Requirements

**A. Reference:** See Part 6 for building telecommunications electrical systems.

**B. Lighting:**

***i.)* Light Levels:** Provide a minimum of 50 foot candles measured three feet above the finished floor. Locate switches adjacent to the latch side of the entrance door(s).

***ii.)* Circuiting:** Lighting fixtures must not be powered from the electrical distribution panel which serves the telecommunications equipment. Dimmer switches must not be used.

***iii.)* E.M.I.:** Lighting shall have low EMI characteristics.

**C. Power:**

***i.)* Circuiting:** A separate electrical circuit serving only the TER shall be provided, terminated with an electrical located in the TER. The amount of electrical power required shall be calculated based on individual project need, and shall include projected future requirements.

***ii.)* Isolated Ground Receptacles:** At a minimum, four (4) quadruplex (or equivalent) wall-mounted receptacles shall be provided, to power telecommunications equipment and related test equipment. All receptacles must be isolated ground, and must be wired (line, neutral, isolated ground, common ground), back to the TER distribution panel. The isolated ground conductor must be terminated on an isolated ground bus which is insulated from the electrical panel steel. The isolated ground must be bonded to the electrical system ground only at the neutral-to-ground bond for the separately derived source supplying the panel. **(See *Designer's Notes* below).**

All receptacles must be labeled and identified in the directory at the distribution panel. Each quadruplex receptacle, or equivalent, must be on its own 20 ampere circuit breaker.

***iii.)* Convenience Receptacles:** In addition to the above, provide non-isolated ground convenience receptacles, marked and labeled, at a maximum of six feet on center around the room perimeter.

***iv.)* Surge Protection:** Surge protection shall be provided for all TER power supply circuits.

***v.)* Transformers:** No transformers are to be located in the TER.

***vi.)* Telecommunications Equipment Grounding:** A ***Telecommunications Main Grounding Busbar (TMGB)*** consisting of a predrilled copper busbar shall be provided. The TMGB shall be connected to Telecommunications Grounding Busbars located in each Telecommunications Closet by means of the building ***Telecommunications Grounding Backbone***. It shall also be connected to the TER distribution panel and the Building Grounding Electrode Conductor through the building electrical services entrance facility. The TER distribution panel should also be connected to the TMGB. Installation of the TMGB and the Telecommunications Grounding system shall be in accordance with ANSI/EIA/TIA-607. **(See also Part 6).**

***vii.)*** **Standby Power:** Electrical Power for the TER shall be on the building standby power system, where one is provided.

***viii.)*** **Security System:** Provision of a security system should be considered for the TER.

***ix.)*** **UPS System:** An uninteruptable power supply (UPS) up to 100kVa shall be permitted in the TER. UPS systems over 100kVs should be located in another space.

***Designer's Note:***
*The isolated ground conducter is intended to extend from the receptacle ground pin to the ground bus of the separately derived source (typically the neutral-to-ground bond on the secondary of the source transformer, or the neutral-to-ground bond at the service entrance equipment). Where isolated ground conductors must pass through a panel board to reach the neutral-to-ground bonding point, they must be terminated on a busbar which is insulated from the panel steel. The purpose of this practice is to reduce common-mode noise (The actual effects of I.G. grounding are variable and somewhat controversial within the industry).*

# 3.6 Telecommunications Closets (TC)

## 3.6.1 Application

The need for a one or more TC shall be analyzed on a project by project basis. In a small school facility, the TER may serve all the functions of a TC, and therefore a separate TC would not be required. A minimum of one TC will be required on each floor of a multi-story building. Note that for exceptionally small projects, a lockable cabinet may substitute for a TC in certain cases, per 1.5.2 (B).

## 3.6.2 Definition

A TC is a secure space dedicated for the use of intermediate telecommunications devices and connections such as Intermediate Distribution Frames and horizontal cross-connects. It is the transition point between the building backbone and horizontal cabling pathways. The definition of, and requirements for, TC are described in TIA/EIA-569A, Part 7.

## 3.6.3 General Requirements

The TC is to be dedicated for the use of building telecommunications equipment only. Electrical installations not related to telecommunications shall not be located in the TC. Additional equipment not related to the support of the Telecommunications systems (e.g., ductwork, piping, conduit, etc.), shall not pass through the TC.

## 3.6.4 Architectural Requirements

**A. Location:** There shall be a minimum of one TC on each floor of a school facility. Additional closets shall be provided where the floor area exceeds 10,000 square feet per closet, or if the length of horizontal distribution cabling required to reach the most remote Telecommunications Outlet will exceed 90 meters (295 feet).

***Designer's Note:***
*Telecommunications Standards limit the length of Horizontal Telecommunications Cabling to a maximum distance of 90 meters from the Telecommunications Outlet to the connecting hardware. This distance is measured along the length of the cable. This usually requires that the actual horizontal distance between the TC and the most remote outlet be significantly less than 90 meters, depending on the proposed cable routing. This distance limitation is independent of the cabling media type.*

***i.)*** **Pathways:** Locate the TC adjacent to the backbone pathway.

***ii.)*** **Water:** Avoid locations in close proximity to water pipes and below lavatory facilities.

***iii.)*** **Corridors:** The TC should be accessible from a corridor.

***iv.)*** **Vibration:** The TC shall be isolated from sources of mechanical vibration.

***v.)*** **E.M.I.:** The TC shall be located away from sources of electromagnetic interference, such as electrical power supply transformers, motors, generators, and radio transmitters. It shall not be located within ten (10) feet of a photocopy machine.

**B. Area Requirements:** Area requirements for a TC can vary widely, depending on the amount and type of equipment and cabling to be accommodated. Each project shall be evaluated on an individual basis. ***The minimum size for new TC shall be 25 net square feet (nsf).*** Adequate clearance shall be provided around telecommunications equipment for maintenance.

> ***Designer's Note:***
> *TIA/EIA-569, Table 7.2-1 recommends T.C. sizing of 10 ft x 7ft (70 nsf) for closets serving a building area of up to 5000 sf, up to a recommendation of 10 ft x 11 ft (110 nsf) for closets serving building areas of up to 10,000 sf. Annex B3 of the Standard describes practices for building areas less than 5000 sf, including walk-in closets of 4.5 ft x 4.5 ft and shallow closets of 2 ft deep x 8.5 ft wide. The minimum acceptable size for schools is the 25 nsf mentioned above. Caution should be exercised in small closets to ensure that clearances in front of electrical panels and telecom equipment conform to applicable electrical codes and allow adequate room for cable routing and maintenance.*

**C. Floor Loading:** Adequate design capacity for floor loading shall be calculated by the building design professional, taking into consideration the proposed equipment weights and layout (including projected future needs), and applicable building code requirements.

> ***Designer's Note:***
> *ANSI/EIA/TIA-569 recommends a minimum floor loading capacity of 50 lbf/ft$^2$. This capacity should be verified as indicated above.*

**D. Finishes:** Finishes shall comply with **Section 3.5.3.** To allow for maximum flexibility, ceiling finishes may be omitted in the TC, except where required to achieve fire assembly ratings. Where ceiling finishes are omitted, wall finishes shall extend to the underside of the floor or roof structure above.

Provide a covering of 3/4" A-C plywood, void free, on at least two walls of the TC capable of supporting wall-mounted equipment. **See 3.5.3** for finishing notes.

**E. Door(s):** Provide a minimum of one (1) 36 inch wide entrance door. Where large equipment is anticipated, consider a 48" door, a 36" door with side panels, or double doors. Center mullions, where required, shall be removable. Doors shall be provided with heavy-duty locks.

## 3.6.5 Mechanical Considerations

**A. HVAC:** The TC shall be maintained at the same temperature and relative humidity as adjacent occupied spaces.

**B. Positive Pressure:** The TER must be maintained under positive pressure relative to adjacent spaces.

**C. Ventilation/Air Conditioning:** Provide adequate ventilation, in accordance with applicable electrical codes, where batteries are provided for back-up power. In the presence of heat-generating equipment, provide adequate ventilation to dissipate the heat. Where standby power is available, the HVAC system serving the TC should be connected. Careful consideration should be given to anticipated after-hours (summer and holiday) temperature and humidity conditions within the TC. LAN electronics in the TC must be maintained within the manufacturers required environmental operating conditions at all times. If air-conditioning is required, **See 3.5.4** above for requirements.

## 3.6.6 Electrical Requirements

**A. Cross-Reference:** Also, see **Part 6** for telecommunications electrical system requirements.

**B. Lighting:**

*i.)* Provide a minimum of 50 foot candles measured three feet above the finished floor. Locate switches adjacent to the latch side of the entrance door(s).

*ii.)* Lighting fixtures must not be powered from the electrical distribution panel which serves the telecommunications equipment. Dimmer switches must not be used.

*iii.)* Lighting shall have low EMI characteristics.

**C. Power:**

*i.)* **Circuiting:** The amount of electrical power required shall be calculated based on individual project need, and shall include projected future requirements.

*ii.)* **Isolated Ground Receptacles:** A minimum of two (2) duplex 120v nominal, non-switched wall-mounted receptacles shall be provided, to power telecommunications equipment and related test equipment. All receptacles must be isolated ground, and must be wired (line, neutral, isolated ground, common ground), in accordance with the requirements of **Part 3.5.5** above. These receptacles must be rated at 20A and be connected to a 20A branch circuit. These circuits must be surge suppression protected.

All receptacles must be labeled and identified in the directory at the distribution panel and at the individual receptacle.

*iii.)* **Convenience Receptacles:** In addition to the above, provide non-isolated ground convenience receptacles, marked and labeled, at a maximum of six feet on center around the perimeter.

*iv.)* **Transformers:** No transformers are to be located in the TC.

*v.)* **Telecommunications Equipment Grounding:** A ***Telecommunications Grounding Busbar (TGB)*** consisting of a predrilled copper busbar shall be provided. The TGB shall be connected to the TMGB, located in the TER, by means of the building ***Telecommunications Grounding Backbone***. The TC distribution panel should also be connected to the TGB. Installation of the TGB and the Telecommunications Grounding System shall be in accordance with ANSI/EIA/TIA-607. **See Part 6.**

*vi.)* **Standby Power:** Electrical Power for the TER shall be on the building standby power system, where one is provided.

***vii.)*** **Security System:** Provision of a security system should be considered for the TER.

***viii.)*** **UPS:** An UPS up to 100kVa shall be permitted in the TER. UPS systems over 100kVa shall be located in another space.

# 3.7 Firestopping

## 3.7.1 Application

Firestopping shall be provided at all locations where a Telecommunications Pathway penetrates a fire-rated building assembly, in accordance with applicable codes. Fire-rated assemblies may include walls, floors, floor/ceiling assemblies and roof/ceiling assemblies.

## 3.7.2 Requirements

The firestopping assembly must meet the same fire-rating criteria as the assembly being penetrated, and must be tested in accordance with ASTM E 814 or UL 1479. **Failure to comply with these requirements will void the fire rating of the entire construction assembly, and can have serious safety consequences.**

***Designer's Note:***
*Telecommunications pathways design must be carefully coordinated with the building design on this issue. Often, in school construction design, a Code review plan is prepared by the architect which indicates all the building fire separations. The telecommunications designer/ installer should consult with the Architect should there be any uncertainty as to the location or fire-rating of construction assemblies. Designers and school system technology coordinators are referred to Annex A of ANSI/EIA/TIA-569A, and to the BICSI Telecommunications Distribution Methods Manual which cover the issue of telecommunications firestopping extensively, and to applicable building codes.*

# Part 4- Telecommunications Wiring Standards

## 4.1 Planning Considerations

### 4.1.1 Overview

This Part describes minimum requirements for cabling types, topologies, distribution and installation. It also outlines acceptable options and suggests possible upgrade paths. **See 1.5** for Application of these requirements.

*Nothing in these Standards shall be interpreted as discouraging LSSs from exceeding these minimum standards, where there is a determination of need, and adequate administrative and financial resources are available for installation and maintenance of the increased capabilities.*

**See Appendix B for a summary of some of the requirements of this section.**

### 4.1.2 General Requirements

**A. Industry Standards:** Wiring Distribution Systems shall conform to the most recent requirements of EIA/TIA-568A, *Commercial Building Telecommunications Cabling Standard* and EIA/TIA-606, *Administration Standard for the Telecommunications Infrastructure in Commercial Buildings* and applicable Federal Communications Commission (FCC) Rules including Part 68 and Subpart J of Part 15, including required FCC registration and numbering.

**B. Non-Ratified Industry Standards:** Note that these MSDE Standards reference non-ratified EIA/TIA-568A requirements for Enhanced Category 5 Unshielded Twisted Pair (UTP) cabling. Until such time as Addenda No. 5 to EIA/TIA-568A is published (currently scheduled for early spring 1999), the latest revision of TIA Standards Proposal SP-4195 "Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling" shall apply.

**C. Additional Standards: See Part 2 (2.1 and 2.2)** for additional information regarding applicable codes and standards.

**D. Control Standards:** The actual network control standard to be implemented in any given facility is at the discretion of the Local School System. Cabling and connecting hardware for data shall have the capacity to support the IEEE 802.3 ("Ethernet") control standard for Local Area Networks (LAN) to the desktop, including 10BaseT, 100BaseT and (when industry standards are ratified) 1000BaseT (four-pair) implementations. Control standards supported by the LAN electronics shall be as required by the local school system for each installation.

> ***Designer's Note:***
> *During an informal survey of Maryland's 24 Public School systems in May of 1998 it was determined that all 24 systems had standardized on Ethernet as the control standard to the desktop. Of the 24, all had 10BaseT implementations, 7 had some 100BaseT implementations and 2 had standardized on 100BaseT to the desktop.*

**E. Capacity**

*i.)* Data/Voice cabling systems must be capable of supporting applications requiring a bandwidth of at least 100Mhz. **See item G** below for additional data system requirements.

*ii.)* Video cable systems shall have sufficient bandwidth to support multi-channel video applications. **See Part 5.**

**F. Compatibility:** Some radio-frequency (RF) based hearing assistance systems (such as are often found in language laboratories) have been found to cause significant interference with both data and video transmission systems. LSSs and Telecommunications Designers are urged to verify the compatibility of all proposed RF technologies with the telecommunications network before proceeding with design. (Note that RF based ADA hearing assistance systems, which operate in the 70-76 MHz range, could theoretically cause interference with video systems, but this has not typically been of concern due to the low-power of these systems).

**G. UTP Data System Performance:**

*i.)* The Horizontal (Enhanced Category 5 based) portion of the data cabling system, including Telecommunications Outlets, cabling, connecting hardware and electronics, shall comply with the proposed *component, link and channel* performance requirements of the latest revision of TIA SP-4195 "Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling" or, on publication, Addendum No. 5 of ANSI/TIA/EIA-568A. Testing of these systems shall also comply with these requirements.

***Designer's Note:***
*The referenced Enhanced Category 5 standards are very stringent and place a large emphasis on total channel performance, rather than on the performance of a particular component such as the cabling. Note that EIA/TIA568-A requires that the installed transmission performance of a link constructed of components not meeting the same performance characteristics shall be classified by the least performing component of the link. In order to meet these new performance requirements, it is critical that all system components be performance-matched.* ***It is strongly recommended that designer's specify a single manufacturer or allied-manufacturer solution to the network design across the entire link.*** *Such systems can be performance warranted by the manufacturer* ***(See 4.9)*** *and result are typically more predictable than the alternative method of purchasing individual components from non-allied sources. There are many manufacturers offering this type of "complete system solution" approach, keeping prices competitive. LSSs wishing to take an individual-component approach should establish "best-of-breed" criteria for each component to ensure optimum link/channel performance. Note that this approach may limit available warranties.*

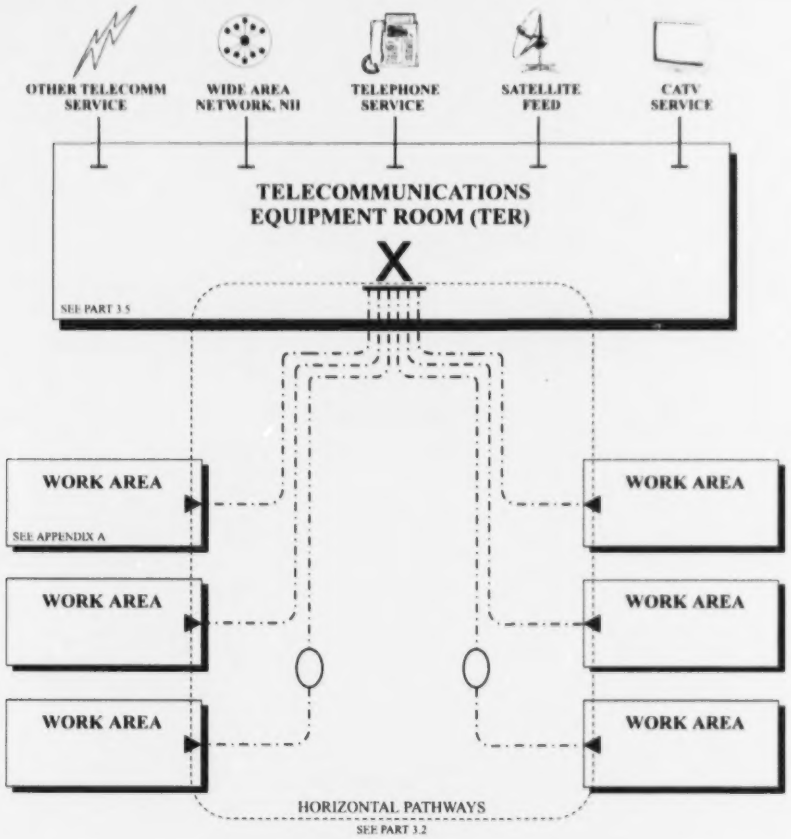
**H. Network Management:** Cable Systems for data shall be designed and configured to allow for full port-level management to the individual Telecommunications Outlet based on Simple Network Management Protocol (SNMP).

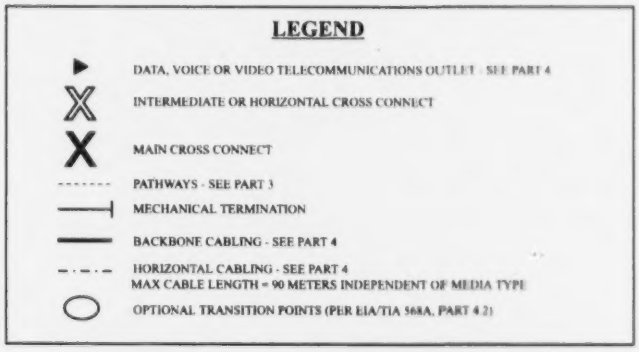
**I. Application:** The following sections discuss standards for the more common issues often encountered in school facilities. In some areas, this Standard may identify allowable deviations from ANSI/EIA/TIA-568A, or provide specific provisions for school facilities not other wise addressed.

**J. Staff Training:** Provisions for school system staff training shall be incorporated into all wiring installation contracts. **See Part 2.4.**

## 4.1.3 Physical Topology

**A. Structured Cabling Systems:** All telecommunications wiring distribution shall be a structured cabling system physically configured in a star topology. This requirement is independent of wiring media type and telecommunications technologies supported unless otherwise noted. **See Part 4.10** for a discussion of Special-Case Network Cabling strategies and **Part 5** for a discussion of alternate video distribution configurations.

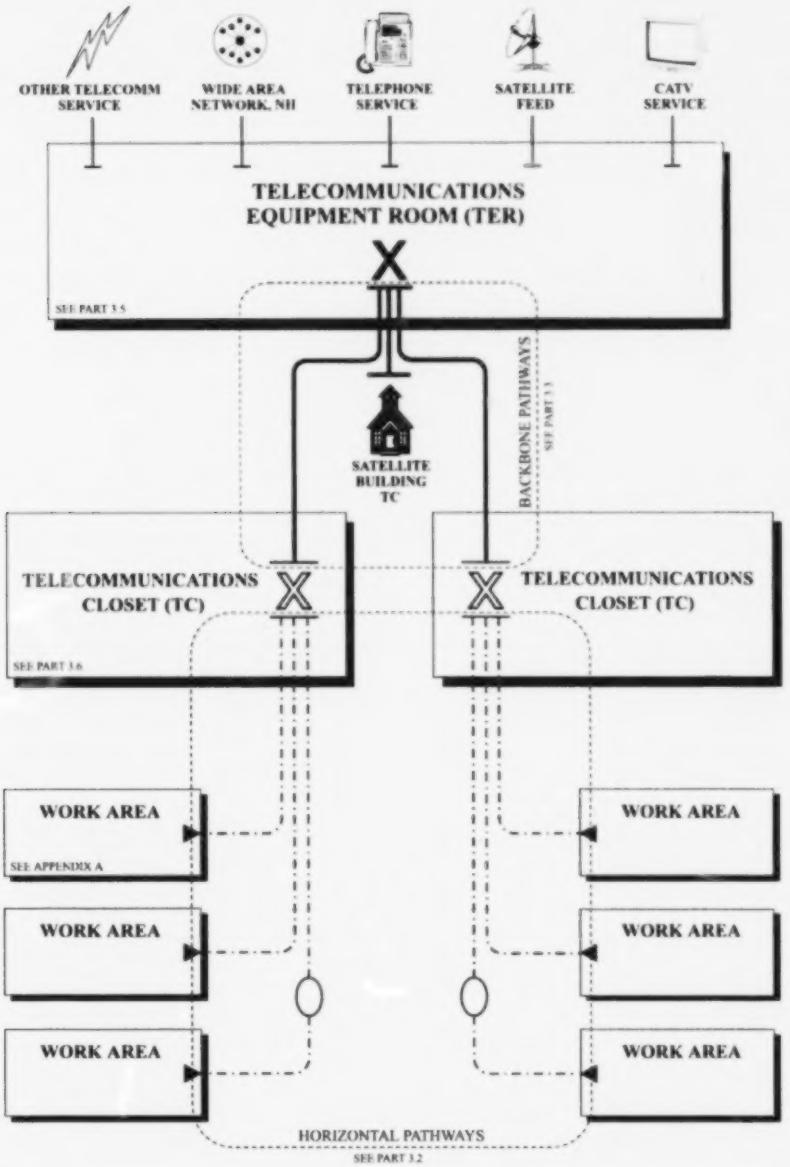




LEGEND
DATA, VOICE OR VIDEO TELECOMMUNICATIONS OUTLET - SEE PART 4
INTERMEDIATE OR HORIZONTAL CROSS CONNECT
MAIN CROSS CONNECT
PATHWAYS - SEE PART 3
MECHANICAL TERMINATION
BACKBONE CABLING - SEE PART 4
HORIZONTAL CABLING - SEE PART 4
MAX CABLE LENGTH = 90 METERS INDEPENDENT OF MEDIA TYPE
OPTIONAL TRANSITION POINTS (PER EIA/TIA 568A, PART 4.2)

# STAR WIRING TOPOLOGY

**(ACCEPTABLE FOR SMALLER FACILITIES WHERE HORIZONTAL CABLE RUNS < OR = 90 METERS)**

**FIGURE 4.1**




# HIERARCHICAL STAR WIRING TOPOLOGY

**(REQUIRED WHERE HORIZONTAL CABLE RUNS > 90 METERS)**

(SEE FIGURE 4.1 FOR LEGEND)

**FIGURE 4.2**

**B. Star Topology:** In smaller facilities, horizontal wiring shall emanate from a single TER, in a standard Star Topology, for termination at each Telecommunication Outlet. **(See Figure 4.1)**

**C. Hierarchical Star Topology:** In larger facilities, where the cabling distance from the Main Cross-Connect to the furthest Telecommunications Outlet would exceed 90 meters (295 feet), telecommunications cabling shall be configured in a hierarchical star topology. This distance limitation is independent of wiring media type. Backbone cabling shall emanate from the main cross-connect located in the TER and terminate at Intermediate and/or Horizontal cross-connects located in remote TC. Horizontal cabling shall originate at the horizontal cross-connects and shall terminate at each Telecommunications Outlet. **(See Figure 4.2)**

**D. Cross-Connects:** The total number of horizontal and backbone cross-connects shall not exceed the number specified in Part 5.2 of EIA/TIA-568A. There shall be nor more than two hierarchical levels of cross-connects in the backbone. No more than one cross-connect shall be installed between the horizontal and main cross-connects. Note that this requirement does not preclude the use of Consolidation Points as described in EIA/TIA Technical Services Bulletin TSB-75: *Additional Horizontal Cabling Practices for Open Offices.*

# 4.2 Telecommunications Outlets and Connectors

## 4.2.1 General Requirements

**A. Quantity:** Telecommunications Outlets (TO) supporting voice, data and video applications shall be provided in all spaces within a school facility (with the exception of janitors closets, toilet rooms, small storage rooms, hallways etc.), in the minimum quantities specified in **Appendix A**.

**B. Definition:** A TO is a single connecting device which provides the interface point between a work area equipment cable and a single horizontal cable.

**C. Configuration:** To the greatest extent practical, *there shall be a minimum of two telecommunications cables and outlets in any one cable drop to the work area outlet box.* These outlets may support the same or complementary technologies (i.e., two data or one voice and one data, etc.) The exact configuration of a TO cluster (i.e., the quantity and type of connectors in a single box or faceplate) shall be as determined by the LSS, based on anticipated use. Any unused (i.e., unwired) outlets in the faceplate shall be covered with blank cover plates.

**D. Location:** The location of the TO within the Work Area shall be determined by the project designer, based on project specific educational requirements, and shall take into consideration the following:

*i.)* The TO should be located within six feet of the anticipated location of computer workstations or telecommunications device.

*ii.)* The TO location must be coordinated with, and within six feet of, the location of dedicated power receptacles. **(See Part 6)**

**E. Mounting:** TOs shall be recessed in new construction and recessed or surface mounted in renovation projects. Outlets shall be mounted in modular faceplate installed in approved metal mounting boxes, surface raceway, power poles, floor receptacle boxes or other approved horizontal pathway devices.

**F. Labeling:** All TOs shall be uniquely labeled with a coding scheme indicating the originating point of the cable. The telecommunications service provided at each outlet (i.e., data, voice, or video) shall be clearly marked for easy identification by the end user by the use of text or symbols. Labeling shall be capable of easy changes if the TO function is modified at the cross-connect. **See also 4.6.**

## 4.2.2 Telecommunications Outlet Specifications

**A. Telecommunications Outlets for UTP Systems (voice, video and data):** Eight-position modular jacks conforming to ANSI/EIA/TIA-568A part 10.4.5 and which meet the mechanical and performance specifications required of the 100 UTP cabling system. TOs shall comply with the applicable provisions of the proposed *component, link and channel* performance requirements specified in the latest revision of TIA SP-4195 "Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling" or, on publication, Addendum No. 5 of ANSI/TIA/EIA -568A.

Pin-pair assignments shall be per the T568A designation. *Optional T568B (AT&T 258A) pin-pair assignments, in which pairs 2 and 3 are transposed, shall be allowed if the LSS has used this as a system-wide standard, and backward compatibility is required.*

***Designer's Note:***
*RJ-11 (4-pin) type voice receptacles are not an approved receptacle type for school projects which fall under the jurisdiction of these Standards, as they do not provide adequate interchangeability with data systems.*

**B. Telecommunications Outlets for multi-mode fiber-optic systems (voice, video and data):** As a minimum, optical-fiber TOs shall be capable of terminating two optical-fibers into a ***568SC connector*** mounted with a ***duplex 568SC adapter insert.*** The TO shall meet the requirements of 568A, Part 12.4.5 and shall comply with the same mechanical and transmission requirements as the optical fiber cabling system. Letter designations **A** and **B** shall be clearly indicated for the two-position adapter, per industry Standards.

***Designer's Note:***
*It is anticipated that the 568SC will remain as the allowed work-area outlet in the future release of EIA/TIA-568B.* ***BFOC/2.5 (Type ST) connectors are not allowed for projects which fall under the jurisdiction of this Standard.*** *However, acceptable upgrade paths for facilities which may already have a large installed base of Type ST connectors are described in Informative Annex F of ANSI/EIA/TIA-568A "Migration Paths for Optical Fiber Connections".*

**C. Telecommunications Outlets for coaxial cabling systems (video systems only):** As a minimum, **extended "F" type connectors with "G" type compatibility** mounted in a baseplate shall be used for video systems employing a coaxial distribution system. Connectors shall meet FCC emissions leakage requirements.

## 4.3 Horizontal Cabling Systems

### 4.3.1 General Considerations

**A. Installation Practices:** Appropriate care shall be utilized to ensure that standards-based installation practices are followed in the installation of Horizontal cabling. This is critical in ensuring system performance over the life-cycle of the installation.

**B. Topology:** All Horizontal Cables shall homerun from each TO to the connecting hardware at the TC or TER in a Star topology. This requirement is independent of cabling media or proposed applications. **Sec 4.1.3.**

**C. UTP Data System Performance:** The Enhanced Category 5 portion of the data cabling system shall comply with the proposed *component, link and channel* performance requirements of the latest revision of TIA SP-4195 "Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling". This shall be superceded by Addendum No. 5 of ANSI/TIA/EIA-568A on publication.

**D. Maximum Cable Lengths:** Horizontal cable lengths shall not exceed 90 meters from the TO connection to the mechanical termination at the horizontal cross-connect. This limitation is independent of cabling media type or proposed applications.

**E. Pathways:** Horizontal cabling shall be installed in pathways meeting the requirements of **Part 3.2**. Plenum grade cable, or approved wireways, shall be used where required by applicable codes.

**F. Grounding:** Horizontal Cabling Systems shall be fully grounded to protect personnel and equipment and to reduce electromagnetic interference associated with the cabling system in accordance with the requirements of ANSI/EIA/TIA-607. **(See also Part 6)**

**G. Cabling Media:** Only acceptable cabling media specified in **4.3.2** below shall be utilized for horizontal cabling.

## 4.3.2 Acceptable Horizontal Cabling Media

**A. Minimum Standards:** The following Section outlines minimum cabling media standards and recognized alternates for horizontal cabling. Minimum requirements pertain to the minimum allowable performance and physical characteristics as defined by ANSI/EIA/TIA cabling specifications.

**B. Enhanced Category 5 Copper UTP cable (Data, Voice and Video systems):** Four-pair, 100 Ohm 24AWG UTP cables consisting of thermoplastic insulated solid conductors, rated for 100 Mhz. Cable shall be certified for EIA/TIA Enhanced Category 5 performance characteristics which conform to ANSI/EIA/TIA SP-4195 *(Proposed addendum to TIA/EIA-568A: Additional Transmission Performance Characteristics for 4-pair 100 Ohm Enhanced Category 5 Cabling)* or, on publication, Addendum No. 5 of ANSI/TIA/EIA-568. UTP cable must meet the requirements of UL 910 and NFPA 262-1985 and shall be clearly marked as Plenum Grade or type CMP if installed in air plenum applications. Cable installed in approved wireways, or in non-plenum ceilings, may be non-plenum rated if allowed by applicable codes.

**C. 75 Ohm Coaxial Cable (Dedicated Video Applications only - see Part 5):** Horizontal coaxial cabling, for broadband video applications, shall be 75 Ohm type RG-6/U. Plenum-rated cable shall be utilized where required by applicable codes. Annex G of ANSI/EIA/TIA-569A provides the following reference standards: IEEE 802.4 (broadband applications), IEEE 802.7 specifications, ANSI T1.404 (DS3) and CATV applications.

## 4.3.3 Recognized Alternatives for Horizontal Cabling

**A. Multi-mode optical-fiber cable:** Two (2) fiber, 62.5/125 µm multimode graded-index optical-fiber waveguide, containing fibers which comply with ANSI/EIA/TIA-492AAAA and are enclosed in a protective cover. All fibers shall meet the physical and performance requirements outlined in Part 12 of the ANSI/EIA/TIA-568A Standard, and *shall have bandwidth capacity of 1 Ghz for the 90 meter (295 ft) horizontal distance specified.* This cable shall be plenum-rated and comply with the requirements of NFPA 262-B.1985 and UL-910 standards if installed in air plenum applications. UL plenum-rated cable must be marked OFNP. Non-plenum-rated cable is acceptable where installed in approved wireways or non-plenum ceilings where allowed by applicable codes. **See Figure 4-3** for Transmission Performance Parameters.

**Figure 4-3**
(Adapted from EIA/TIA-568A Figure 12-1)
Horizontal 62.5/125 µm Optical-Fiber Cable
Transmission Performance Parameters

| Wavelength (nm) | Maximum Attenuation (dB/km) | Minimum Information Transmission Capacity (MHz-km) |
|---|---|---|
| 850 | 3.75 | 160 |
| 1300 | 1.5 | 500 |

NOTE - The information transmission capacity of the fiber, as measured by the fiber manufacturer, can be used by the cable manufacturer to demonstrate compliance with this requirement.

**B. Hybrid or Composite cables:** Hybrid or Composite cables (i.e., several of the above recognized cables enclosed in a common sheath), which meet the transmission, crosstalk, and color coding requirements of ANSI/EIA/TIA-568A 13.1, are an acceptable cabling solution.

**C. Undercarpet Cables:** Specialized Work Area undercarpet cabling used as a segment of the horizontal cabling extending from a transition point (usually in a wall or column) to the TO is an acceptable cabling solution. UTP undercarpet cabling shall meet the Pair Assembly, color coding, transmission, performance marking and installation requirements of ANSI/EIA/TIA-568A, Parts 10 and 13.2, and ANSI/IPC-FC-211.

***Designers Notes for Horizontal Cabling Media***

A. ***Category 6 (UTP) and Category 7 Pairs-in-Metal-Foil (PIMF) cabling:*** *Standards are currently under development for these two cabling types. Several cabling products currently being marketed claim CAT 6 or CAT 7 performance.* ***This MSDE Standard does not support these proposed cabling solutions for schools until such time as industry-wide Standards are ratified.*** *Recent history has shown that installations done on the presumption that a cabling system will meet proposed standards often have failed to meet these Standards when finalized. For example, many pre-Standard CAT 5 systems are unable to support Fast Ethernet. These proposed cabling solutions may appear in future versions of this Standard.*

B. ***Two-pair UTP cable systems (e.g.: two-pair 150 Ohm shielded twisted-pair (STP-A) cables) are not an acceptable cabling media for school facilities.*** These cable types will not support upward migration to network control standards requiring four-pairs such as 1000Mb/s Ethernet.

C. ***100 Ohm Screened twisted pair cable may be used in applications where EMI shielding is required.*** *Designers are referred to Annex G of EIA/TIA-568A for notes regarding grounding and installation. The use of this type of cable is unusual in most public school applications due to cost.*

D. ***50 Ohm coaxial cable:*** *While the current EIA/TIA standard includes 50 Ohm coaxial cable as a recognized horizontal cable type, it is not recommended for new cable installations and is expected to be dropped from the next version of the EIA/TIA Standard.* ***50 Ohm coaxial cable is not acceptable for school cable installations.*** *See Part 5 for a discussion of acceptable video distribution alternatives.*

E. ***Category 3 UTP:*** *Note that* ***Category 3 cable is not a recognized cable type*** *for school projects which fall under the jurisdiction of this standard.*

F. ***Multi-pair UTP cables in excess of four pairs are strongly discouraged for horizontal distribution in school facilities,*** *and should be considered as a "special case" installation for voice systems only. Where there is a strong determination of need for horizontal multi-pair cable, the horizontal cable configuration must be engineered to meet the multi-pair* ***backbone*** *cabling specifications outlined in ANSI/EIA/TIA-568A, part 10.3 and shall meet the requirements of ANSI/ICEA S-80-576. Designers are also referred to Informative Annex D of ANSI/EIA/TIA-568A "Shared Sheath Guidelines for Multipair UTP Cables".*

G. ***Coaxial cable:*** *Detailed Standards for* ***coaxial cable*** *are not included in the ANSI/EIA/TIA-568A Standard. Video applications may also be transmitted over the UTP or optical fiber systems specified* ***-See Part 5.***

## 4.3.4 Horizontal Cross-Connects & Connecting Hardware

**A. Cross-connections:** As required by the EIA/TIA-568A standard, cable terminations shall be made through a series of cross-connects, in order to facilitate moves, adds and changes to the networks.

**B. Standards:** All cross-connect hardware and cables shall be EIA/TIA-568A compliant and shall be tested and certified to meet or exceed the same or greater minimum transmission performance characteristics as the building cabling (**see 4.1 and 4.3.2**).

**C. Horizontal UTP data cross-connects:** Shall be a passive transition between the horizontal building cabling and the network equipment which may be in the same or adjacent racks. Termination hardware and wire management shall allow for the proper termination of horizontal data building cabling to the rear of the termination hardware on 110-style Insulation Displacement Contacts (IDC). The connection to adjacent network hardware shall be by means of patch cords from a termination field of modular 8-pin jack ports at the front of the equipment. Modular jack ports shall be wired to the EIA/TIA T568A pin-pair standard (the T568B scheme may be used as an alternate - **see 4.2.2A**).

**D. Horizontal UTP voice system cross-connects:** Shall be a passive cross-connect between horizontal rack or wall mounted 110-type frames and backbone rack or wall mounted 110-type frames. Termination hardware and wire management shall allow for the proper termination of horizontal voice building cabling to the termination hardware on 110-style IDC. Cross-connects shall be executed by means of 4-pair modular-jack type patch cables (preferred for Move-Add-Change management) or IDC jumper cables. Frames shall consist of field-terminated wiring blocks, horizontal wire troughs, punch blocks, and other wire management accessories.

Sufficient capacity should be provided to allow for the activation of four-pair of conductors for each room served by the TC. *Cross-connect components, blocks and accessories should be sized to accommodate the horizontal and backbone pair-counts to be accommodated in the closet, plus 15% spare to allow for future growth.*

**E. Horizontal Fiber Cross-Connects:** Where horizontal fiber cabling may be utilized, the horizontal cross-connect shall be through optical fiber patch panels. Cross-connects shall be by means of optical-fiber patch cables utilizing type SC or Small Form Factor (SFF) conductors which are EIA/TIA-568A compliant.

# 4.4 Backbone Cabling Systems

## 4.4.1. General Considerations

**A. Installation practices:** Appropriate care shall be utilized to ensure that proper installation practices are followed in the installation of Backbone cabling. This is critical in ensuring system performance over the life-cycle of the installation.

**B. Cabling Media:** Only acceptable cabling media specified below shall be utilized for backbone cabling.

**C. Topology:** Backbone Cables shall homerun from each TC to the connecting hardware TER in a Star Topology. This requirement is independent of cabling media or proposed applications.

**D. Cable Lengths:** Backbone cable lengths shall not exceed distances described in EIA/TIA-568A Part 5.5 for each cable type. These requirements are summarized in **Figure 4-4** below:

**Figure 4-4**
Maximum Backbone Cabling Distances (i)

| | |
|---|---|
| UTP (*Voice applications only*): | 2,624 feet ( 800m) (ii) |
| 62.5/125 m optical fiber: | 6,560 feet (2000m) |
| Single-mode optical fiber: | 9,840 feet (3000m) |

*i.)* Maximum distances are application dependant. See EIA/TIA-568A Part 5.5 for more detailed requirements and 5.5.2 for Entrance Facility Requirements.

*ii.)* Category 5 UTP cabling distances are limited to a total of 295 feet (90m) where applications utilize a spectral bandwidth in the range of 20MHz to 100MHz.

**E. Pathways:** Backbone cabling shall be installed in pathways meeting the requirements of **Part 3.2.** Plenum grade cable, or approved wireways, shall be used where required by applicable codes.

**F. Campus (Interbuilding) Backbone:** Backbone cabling for inter-building use shall meet the same requirements as intra-building backbone cabling, except outdoor-use cable shall be specified. Gel-filled cabling shall be used for all Interbuilding applications.

**G. Grounding:** Backbone Cabling Systems shall be fully grounded to protect personnel and equipment and to reduce electromagnetic interference associated with the cabling system in accordance with the requirements of ANSI/EIA/TIA-607. **See also Part 6**.

## 4.4.2 Acceptable Backbone Cabling Media

**A. Minimum Standards:** The following Section outlines minimum cabling media standards and recognized alternates for backbone cabling. Minimum requirements pertain to the minimum allowable physical and performance characteristics as defined by ANSI/EIA/TIA cabling specifications.

**B. Multi-mode optical-fiber cable:** Twelve (12) fiber, 62.5/125 µm multimode graded-index optical fiber waveguide containing fibers which comply with ANSI/EIA /TIA-492AAAA and are enclosed in a protective cover. All fibers shall meet the physical and performance requirements outlined in Part 12.2 of the ANSI/EIA/TIA-568A Standard. This cable shall be plenum-rated and comply with the requirements of NFPA 262-1985 and UL-910 standards if installed in air plenum applications, (UL plenum-rated cable must be marked OFNP). Non-plenum-rated cable is acceptable where installed in approved wireways or non-plenum ceilings, where allowed by applicable codes. **See Figure 4-5** for Transmission Performance Parameters.

**Figure 4-5**
(Adapted from EIA/TIA-568A Figure 12-2)
Backbone 62.5/125 µm Optical Fiber Cable Transmission Performance Parameters

| Wavelength (nm) | Maximum Attenuation (dB/km) | Minimum Information Transmission Capacity (MHz-km) |
|---|---|---|
| 850 | 3.75 | 160 |
| 1300 | 1.5 | 500 |

NOTE - The information transmission capacity of the fiber, as measured by the fiber manufacturer, can be used by the cable manufacturer to demonstrate compliance with this requirement.

**C. 75 Ohm Coaxial Cable (Dedicated Video Applications only - see Part5):** Intra-building backbone coaxial cabling, for broadband and video applications from 5MHz to 1GHz, shall be 75 Ohm, type RG-11/U or RG-6/U. Plenum-rated cable shall be utilized where required by applicable codes. Annex G of ANSI/EIA/TIA-569A provides the following reference standards: IEEE 802.7 (broadband LAN applications), ANSI T1.404 (DS3) and CATV applications standards. Inter-building backbone cabling shall be RG-11/U or Series 500 cable.

**D. High pair count (i.e., 25, 50, 100, 200 or 300-pair) 100 Ohm 24AWG UTP cable (Voice Applications Only):** Thermoplastic insulated solid conductors, rated for 20 Mhz. Cable shall be certified for EIA/TIA Category 3 Performance characteristics. The cable must be engineered to meet the multi-pair backbone cabling specifications outlined in ANSI/EIA/TIA-568A, part 10.3 and shall meet the requirements of ANSI/ICEA S-80-576. Designers are also referred to Informative Annex D of ANSI/EIA/TIA-568A "*Shared Sheath Guidelines forMultipair UTP Cables*". UTP cable must meet the requirements of UL 910 and NFPA 262-1985 and shall be clearly marked as Plenum Grade or type CMP if installed in air plenum applications. Cable installed in approved wireways, or in non-plenum ceilings, may be non-plenum rated if allowed by applicable codes.

## 4.4.3 Recognized Alternatives for Backbone Cabling

**A. Composite Fiber-optic cables:** Composite fiber-optic cables (i.e., cables containing surplus single-mode optical fibers in addition to the required multi-mode fibers in a common sheath for purposes of providing future capacity) which meet the transmission and color coding requirements of ANSI/EIA/TIA-568A, are an acceptable alternative cabling solution. These single-mode fibers may be left "dark" (unterminated) for future use.

## 4.4.4 Recognized Supplements to Backbone Cabling

**A. Single-mode optical fiber cable:** Class IVa Dispersion-Unshifted Single-Mode optical-fiber cabling complying with Part 12.3 of ANSI/EIA/TIA-568A and ANSI/EIA/TIA-492BAAA may be added to the backbone cabling system as a means of providing additional future capacity. A minimum of twelve fibers is recommended. These single-mode fibers may be left "dark" (unterminated) for future use.

**B. Enhanced Category 5 Copper UTP cable (For smaller schools in which Telecommunications Closet to Telecommunications Equipment Room cabling distances do not exceed 295 feet (90m)):** UTP cable may be utilized to supplement (not replace) multi-mode fiber backbone in smaller schools. The total number of cables should be determined based on specific project requirements. Specifications are as follows:

Four-pair, 100 Ohm 24AWG UTP cables consisting of thermoplastic insulated solid conductors, rated for 100 Mhz. Cable shall be certified for EIA/TIA Enhanced Category 5 performance characteristics which conform to ANSI/EIA/TIA SP-4195 (*Proposed addendum to TIA/EIA-568A: Additional Transmission Performance Characteristics for 4-pair 100 Ohm Enhanced Category 5 Cabling).* UTP cable must meet the requirements of UL 910 and NFPA 262-1985 and shall be clearly marked as Plenum Grade or type CMP if installed in air plenum applications. Cable installed in approved wireways, or in non-plenum ceilings, may be non-plenum rated if allowed by applicable codes. Designers are also referred to Informative Annex D of ANSI/EIA/TIA-568A "*Shared Sheath Guidelines for Multipair UTP Cables*".

***Designer's Notes For Backbone Cabling Media***

*A.* ***50 Ohm coaxial cable****: While the current EIA/TIA standard includes 50 Ohm coaxial cable as a recognized horizontal cable type, it is not recommended for new cable installations and is expected to be dropped from the next version of the EIA/TIA Standard.* ***50 Ohm coaxial cable is not acceptable for school cable installations****. See Part 5 for a discussion of acceptable video distribution alternatives.*

*B.* ***50 micron (50/125 µm) optical fiber:*** *Although this cable type has many desirable performance characteristics, industry-wide standards to ensure multi-vender interoperability, connector standards, etc., have not yet been developed.* ***Therefore, this standard does not recognize 50 micron (50/125 µm) optical fiber as an acceptable backbone cabling type for schools.*** *This cabling system type may be recognized in future versions of this Standard, as EIA/TIA standards are ratified.*

## 4.4.5 Minimum School Facility Backbone Cabling

**A. Minimum Conductors:** The following criteria shall be used for determining the minimum quantity of backbone cabling conductors. The actual number of active and redundant (future-use) conductors for a particular school project should be developed in consultation with the LSS based on projected needs, project budget and other project specific criteria. Conductor counts should be rounded up to the next standard cable size.

**B. FiberOptic Backbone (data, voice, and video):** 12 strands of multi-mode fiber from each TC. If the cabling scheme includes any *horizontal* fiber-optic cabling, then backbone cabling strand count should be at a 1:1 ratio with the number of horizontal fibers terminated in the TC, *plus* the 12 strand minimum for the remainder of the network.

**C. UTP backbone for voice systems:** 4 pair for each room served by each TC, plus 15% spare to allow for future growth.

**D. Coaxial backbone for video systems:** Minimum of two runs of cable between the TER and each TC.

## 4.4.6 Main Cross-Connect and Connecting Hardware

**A. Cross-Connects:** As required by the EIA/TIA-568A standard, cable terminations shall be made through a series of cross-connects, in order to facilitate moves, adds and changes to the networks.

**B. Transmission Performance:** All cross-connect hardware and cables shall be EIA/TIA-568A compliant and shall be tested and certified to meet or exceed the same or greater minimum transmission performance characteristics as the building cabling. **(See 4.1.2 and 4.4.2)**

**C. Main (or Intermediate) Cross-Connects:**

*i.)* Fiber Cross Connects: The main fiber cross-connects shall be a passive transition between the optical fiber backbone termination hardware and the network equipment, which may be in the same or adjacent racks. Termination hardware and cable management shall allow for the proper termination of backbone building cabling in standards compliant optical fiber patch panels. Cross-connects shall be by means of optical-fiber patch cables utilizing type SC or SFF connectors which are EIA/TIA-568A compliant from a termination field of modular jack ports at the front of the equipment.

*ii.)* Main Voice System Cross-Connect: The main voice system cross-connect shall be a passive cross-connect between rack or wall mounted 110-type frames consisting of field-terminated connecting blocks, horizontal wire troughs punch blocks, and other wire management accessories. Cross-connects shall be executed by means of 4-pair modular-jack type patch cables (preferred for Move-Add-Change management) or IDC jumper cables. Blocks should be sized to accommodate the horizontal and backbone pair-counts required to service each TC, plus 15% spare to allow for future growth. The connection to the telephone service Demarcation Point shall be through standards-compliant high pair count (typically 150 plus) Category 3 tie cable.

*iii.)* Jumper and Patch Cord lengths should not exceed 66 feet (20m) at the Main Cross-connect.

**D. Video Systems:** See Part 5 for coaxial video system requirements.

# 4.5 Equipment Room & Closet Cable Terminations

## 4.5.1 General Requirements

**A. Cable Termination Practices:** Practices for the termination of cabling systems within the TER and TCs shall comply with the requirements of EIA/TIA-568A. In general, cable termination facilities shall have the following characteristics:

***i.)* Dedicated Space:** Terminations shall be made in rooms or spaces dedicated for this purpose. For physical and utility requirements for TER and TCs, refer to **Parts 3.5 and 3.6.**

***ii.)* Organization:** Cable termination facilities shall be well-organized and provide adequate space for maintenance, modification and expansion. The relationships between cross-connect hardware shall be organized so as to accommodate network Move-Add-Change (MAC) management.

***iii.)* Cross-connects:** Cabling terminations shall be executed through a series of cross-connects to ensure system flexibility, expandibility and ease of maintenance. **See 4.3.4** (Horizontal Cross-Connects) **and 4.4.6** (Main Cross-Connects).

***iv.)* Compatible Hardware:** Connecting hardware and cables must be standards-compliant and capable of supporting the same or greater transmission performance specifications as the cabling plant.

***v.)* Cable Management:** Cable Management strategies must be employed to maximize system performance capabilities, to ensure long-term reliability of the system, and to provide ease in troubleshooting and systems maintenance.

***vi.)* Grounding and Bonding:** All termination hardware shall be adequately grounded to the building Telecommunications Grounding and Bonding System. **(See also Part 6).**

***vii.)*** **Labelling and Identification:** All components of the cabling system, including the cable termination facilities, shall be thoroughly labelled in accordance with a standards-based identification scheme.

***viii.)*** **Documentation:** The entire cable plant installation shall be thoroughly documented for future reference. **See Part 4.8.**

## 4.5.2 Equipment Room Organization and Layout

**A. Organization:** TERs and TCs should be well organized in order to facilitate system maintenance, neat and orderly cross-connect administration and network MAC management.

**B. Racks and Frames:** Connecting hardware and termination devices (patch panels and punchblocks) shall be installed in standard EIA/TIA 19" equipment racks, either floor or wall mounted, or in wall mounted distribution frames. Equipment racks shall be provided with adequate cable management hardware (**See 4.5.4**). Where utilized, wall-mounted voice system punch blocks shall be installed on a well-organized wallfield, provided with adequate wire management hardware. All wall-mounted equipment shall be installed on 3/4" fire retardant treated plywood backerboard.

**C. Maintenance Clearance:** Adequate maintenance clearance shall be provided around equipment racks in accordance with equipment manufacturers requirements and the requirements of applicable codes, including accessibility requirements. *At a minimum there shall be three (3) feet of clearance from the front and rear mounting surfaces at least one side of all racks. Racks placed with one side to the wall should have at least 6" clear between the rack and the wall.* As an alternate to the 3 ft. clearance behind the racks, hinged racks which can swivel out 90 degrees for maintenance may be utilized. The use of this rack type requires careful attention to cable management in order to allow enough slack cable to rotate the rack without producing stress on the connectors.

**D. Future Changes:** Consideration shall be given to the potential for network moves and changes. The voice system cross-connect shall be located in close proximity to the data system cross-connect (on the same or adjacent wall surfaces, but never exceeding the maximum patch cord length recommendations of the EIA/TIA-568A standard), with a clear pathway left for future cross-connecting.

**E. Furniture:** Depending on the schools system's concept for technology management, the owner may wish to install additional furniture or equipment in the TER or TC. This may include a work area for the systems administrator, file and drawing storage for system documentation and/or file servers and related equipment. The layout of the TER should take these needs into consideration during early planning. Network file servers should be accommodated on a desktop or on racks where they can be protected from accidental damage.

**F. Grounding:** All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays and equipment, etc., residing in the TER or TC shall be grounded to the respective TMGB or Telecommunications Grounding Busbar (TGB) using a minimum #6 AWG stranded copper bonding conductor and compression connectors. All grounding conductors shall be identified with green insulation. Non-insulated grounding conductors shall be wrapped with green tape at the connection. **See Part 6.**

## 4.5.3 LAN Electronics

**A. Channel Performance:** LAN electronics such as hubs, concentrators and switches are to be EIA/TIA standards compliant and capable of meeting or exceeding the full component, link and channel performance specifications of the associated cabling system.

**B. Capacity:** Sufficient hubs/concentrators and switches (where utilized) shall be provided so as to provide active connections to one hundred percent (100%) of the number of data TOs required by Appendix A, plus 2% reserve capacity for each closet or equipment room.

**C. Control Standards:** Network control standards to be implemented in a particular school facility are at the discretion of the LSS. LAN electronics shall be engineered to fully support the selected protocols.

**D. System Management:** LAN electronics shall fully support port - level system management through Small Network Management Protocol (SNMP). Unmanaged or "dumb" hubs do not meet the requirements of this Standard. **See Part 4.10.2** for a discussion of "compressed backbone" implementations.

**E. Installation:** LAN electronics are to be located in the same or adjacent TIA 19" equipment racks or wall-mounted distribution frames as the distribution hardware. Network connections to the distribution hardware shall be made through EIA/TIA-568A compliant fiber or Enhanced Category 5 UTP patch cables.

**F. Switched Networks:** Segmenting a LAN by means of switches can be an effective way to manage a network, improving both network performance and security. Although not always required, switches may be necessary for implementing high-speed control standards and server connections, especially on robust LANs. Although the use of switching technology is encouraged, switches are not required by this MSDE standard. Their use should be in alignment with the requirements of the particular network design, control standard, and proposed use. It is recommended that non-switched networks provide provisions (rack space, etc.) for a future upgrade to switching.

**G. Grounding:** All LAN electronics shall be grounded through the building Telecommunications Grounding and Bonding system. **(See Part 6)**. TC equipment shall be grounded to the closet TGB. TER equipment shall be grounded through the TMGB.

## 4.5.4 Cable Management & Installation Practices

**A. System Performance:** EIA/TIA performance specifications for cabling systems, including connecting hardware, are predicated on the use of correct installation and cable management techniques. If recommended installation and management techniques are not observed, the specified transmission performance criteria for the cabling system may not be achieved.

**B. Cable Management:** Good cable management practices shall be followed in accordance with EIA/TIA standards, manufacturers recommendations and best industry practices. Features of good cable management include the following:

*i.)* All cabling shall be neatly and logically routed, bundled and dressed in order to facilitate easy maintenance, troubleshooting, system documentation and Move-Add-Change management and in order to ensure specified system performance.

*ii.)* All cabling shall be adequately supported by the use of trays, ladder racks, "D" rings or equivalent wire management and support structures.

*iii.)* Precautions should be observed to eliminate cable stress and twisting in suspended cables or cable bundles. Maximum allowable cable stress is specified in the EIA/TIA 568A standard and by the cable manufacturer. All cables are to be neatly dressed using cable ties that are hand tightened, not machine tightened.

*iv.)* **UTP cabling:** UTP cabling must be installed so as provided minimal signal impairment by preserving wire-pair twist as closely as possible to the point of mechanical termination. The amount of pair untwisting at the point of connection to hardware shall not exceed 0.5" (13mm). A minimum bend radius of at least four (4) times the cable diameter shall be provided at all times (horizontal cable) or ten times (multi-pair cable).

*v.)* **Optical-Fiber Cabling:** Fiber slack shall be neatly coiled within the fiber termination panels. Each cable shall be mechanically attached to the respective termination panel. The cables strength members shall be securely attached to the cable strain relief bracket in the panel. Dust caps shall be installed on all fiber connectors and couplings which are not physically connected and in use.

## 4.6 Labeling and Identification

**A. General Requirements:** All installed components shall be clearly marked with a consistent standards-based labeling scheme. The labeling system shall clearly identify all components of the system: outlets, cabling, pathways, termination hardware, racks, and equipment. It shall designate the cables origin and destination with a unique identifier for each cable within the system.

**B. Legibility:** Insert labels shall meet the legibility, defacement and general exposure requirements specified in UL 969. Cables are to be labeled at their entrances to the termination hardware or outlets. Cables labeled within the bundle are not acceptable.

**C. Identification Standard:** Pathway, Space and Wiring System identification shall be in accordance with EIA/TIA-606 *"The Administration Standard for The Telecommunications Infrastructure of Commercial Buildings"*, however alternate identification standards may be utilized at the discretion of the LSS where the LSS has an existing identification standard in place. Note that the identification scheme must be building-specific and clearly identify the relationship between the cabling infrastructure and the spaces served by the use of unique space identifiers incorporated into the labeling scheme.

**D. Documentation:** All labeling information shall be recorded on the as-built documentation. All test documents shall reflect the building labelling scheme. **(See also 4.7)**

**E. Performance Labeling:** In addition to identification labeling, Article 10.6 of EIA/TIA-568A recommends performance labeling of the entire link from the TO to and including the connecting hardware. The requirements for performance labeling, if any, shall be determined by the LSS. Where system performance labeling is installed, it should be clearly distinguishable from the performance labeling of the individual system components such as TOs/connectors and cables. Performance labeling is an addition to, and does not replace, labeling required by listing agencies and as needed to meet the requirements of the electrical code or other statutory requirements.

## 4.7 Testing and Acceptance

**A. General Requirements:** All cables and termination hardware shall be 100% tested for defects in installation and to verify conformance with performance specifications under installed conditions. Tests shall be conducted in accordance with the most recent requirements of the EIA/TIA-568A standard. All conductors of each installed cable shall be verified and all defects in the distribution system shall be corrected prior to system acceptance including, but not limited to, outlets, cables, connectors, patch panels, feedthrough couplers, patch cords and jumpers and connecting blocks. All test results shall be thoroughly documented for the project record.

**B. UTP Copper Cable System Testing:**

***i.)* UTP Voice Cables:** Each UTP copper voice cable shall be tested for continuity (on all pairs and/or conductors), polarity and pair reversals, shorts and opens. Shielded or screened cables shall also be tested with a device that verifies shield continuity. Horizontal voice cabling shall also be tested to meet the same performance specifications as the horizontal data cabling and for length.

***ii.)* UTP Data cables**: Each UTP copper data cable shall be tested for all of the above requirements, plus tests to verify the installed performance.

***iii.)* Length:** All installed cables shall be tested for length. Cables shall be tested from patch panel to patch panel, block to block, patch panel to TO or termination block to TO as appropriate. All cable lengths shall conform to the EIA/TIA-568A standard. For multipair cable, the length of the longest pair shall be recorded as the length of the cable.

*iv.)* **Performance Verification:** Enhanced Category 5 cabling systems shall be tested to verify conformance to the performance specification using an automated test set. The most recent version of the EIA/TIA-568A performance criteria and test methods shall be utilized, including the requirements of TIA SP-4195 "Additional Transmission Performance Specifications for 4-Pair 100 Ohm Enhanced Category 5 Cabling". This shall be superceded by Addendum No. 5 of ANSI/TIA/EIA-568A on publication. The test set shall be capable of testing for the criteria outlined above, plus the following: Power Sum Near End CrossTalk (NEXT), Attenuation, Ambient Noise and Attenuation to Crosstalk Ratio (ACR). This testing shall be bidirectional.

**C. Optical Fiber Cable System Testing:**

*i.)* **Visual Inspection:** All optical fiber terminations shall be visually inspected with a minimum 100x microscope to ensure that no surface imperfections exist after polishing.

*ii.)* **Attenuation:** Each fiber strand shall be tested for attenuation with an optical power meter and light source. Horizontal multimode fiber (if any) shall be measured at either 850 nanometers (nm) or 1300 nm using an LED light source in one direction. Backbone multimode fiber shall be tested at both 850 nm and 1300 nm in one direction. Testing setup and performance shall be conducted in accordance with the ANSI/EIA/TIA-526-14 Standard. Test evaluation shall be based on the values indicated in EIA/TIA-568A, Annex H: *Optical Fiber Link Performance Testing.*

*iii.)* **Length and Splice Loss:** Where required below, optical-fiber cable shall be tested with an Optical Time Domain Reflectometer (OTDR) to verify installed cable length and splice losses. These tests shall be required in the following circumstances: Where OTDR testing is requested by the LSS, where abnormal or unexpected attenuation test results occur, and where the cable has been subjected to extreme conditions or stresses during installation. Each strand shall be tested on all outside plant cable and/or where splices exist. Length testing of a representative strand is required if the estimated cable length is within 10% of the EIA/TIA-568A maximum. Length measurements shall be performed in accordance with EIA/TIA-455-60.

**D. Coaxial Cable System Testing:** See Part 5.

# 4.8 System Record Documents

**A. General Requirements:** The entire telecommunications distribution system is to be thoroughly documented for the future reference of the school system. The specific requirements for as-built documentation are at the discretion of the LSS. Sufficient copies should be provided to maintain at least one copy at the installation site. The following items should be provided as a minimum.

**B. Labeling:** All labeling on system documentation is to be consistent with the building-standard labelling and identification scheme. **See 4.6.**

**C. "Record" Drawings:** Drawings indicating the final "as-built" condition of the telecommunications distribution system shall be provided. These may be transmitted in paper and/or electronic format as required by the Owner. These should be maintained and updated by the installation contractor on a daily basis during installation, and finalized at the end of the installation. Drawings should include floor plans clearly indicating all system components, including outlet locations and configurations, cable routing, cable trays, conduit and other pathways, and the layout of termination hardware and distribution equipment. Detailed elevation drawings of all telecommunications closets and equipment shall be provided, showing equipment layouts and termination positions for all cabling.

**D. Test Documentation:** Documentation of all acceptance testing shall be provided. Test information shall be presented in clearly divided major headings for Horizontal and Backbone systems. Within each section, scanner test results (UTP cable), fiber-optic attenuation test results and continuity test results shall be provided. Where specific components may have failed testing, test results of both before and after the remedial action shouls be provided. Provide information regarding the testing equipment, including name, manufacture, model number and last calibration date. The test document shall detail the test method used, the date, and the specific settings of the equipment during the test.

**E. Outlet Database:** A database of outlet designations is recommended. This information could be exported to cable management software system by the owner, for use in tracking future adds and changes.

**F. Manuals:** Provide project manuals including other miscellaneous project data such as component specification sheets, and maintenance information.

**G. Warranties:** Provide thorough documentation of all system warranties and warranty requirements. **See 4.9.**

**H. Staff Training:** **See Part 2.4** for school system training and review of project documents.

## 4.9 Warranties

**A. General Requirements:** All cabling systems which fall under the jurisdiction of these standards shall be provided with installation and cabling system warranties. The specific terms of the warranties shall be as determined by the LSS as required to meet local need and in order to ensure conformance with local and/or State procurement practices and/or existing contracts. *The following warranty terms are strongly recommended as a minimum requirement, but are not mandated by this MSDE standard.* **See Part 5** for video system warranty recommendations.

**B. Installation Warranty:** The contractor should warrant the cabling system against defects in workmanship for a period of one (1) year from the date of system acceptance by the school system. The terms of acceptance should be clearly defined by the school system and designer. The warranty should cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished.

**C. Cabling System Performance Warranty:** The contractor should facilitate the implementation of a manufacturers performance warranty. The performance warranty should warrant properly installed 100MHz horizontal UTP copper and both the horizontal and backbone optical-fiber portions of the cabling system for a period of fifteen (15) years (minimum - longer warranties are available) from the date of system acceptance by the school system. UTP copper links should be warranted against the link performance minimum expected results defined in the most recent EIA/TIA standards for Enhanced Category 5 systems. Fiber optic links should be warranted against the link and segment performance minimum expected results defined in the EIA/TIA-568A, Annex H: *Optical Fiber Link Performance Testing.*

***Designer's Note:***
*The requirements for a system performance warranty of this type cannot generally be met without a single-manufacturer or allied-manufacture implementation of the cabling system utilizing performance-matched components. Many manufacturers are now able to offer this type of warranty associated with their "complete system" solutions. Implementation of these systems is accomplished through a network of manufacturer-certified contractors.* ***(See also 4.1.2 G)***

# 4.10 Special-Case Network Cabling Strategies

## 4.10.1 Overview

**A. Alternate Network Configurations:** The following sections outline requirements for two technologies which have seen some limited application in Maryland's Public Schools. These network solutions do not comply with the requirements of 4.1.2, or are not yet feasible for whole-building networking solutions. The use of these systems is to be limited to "special case" installations as a supplement to the Standards-compliant systems outlined above.

## 4.10.2 Compressed Backbone ("Fiber to the Classroom") LAN

**A. Definition:** Compressed Backbone (commonly referred to as "Fiber to the Classroom") implementations refer to LAN topologies which provide horizontal optical fiber cable distribution to unmanaged fiber-to-copper electronics (mini-hubs) located in each work area. Distribution to the the individual TOs from the mini-hubs is then accomplished via UTP copper cabling within the classroom. This network solution does not comply with the requirements of 4.1.2, particularly the requirements for compliance with the EIA/TIA-568A standard and the ability to provide network management capability to the individual TO. This approach must be distinguished from "Fiber to the Desktop" solutions in which horizontal optical-fiber cabling is run to the individual TO.

**B. Application:** ***This MSDE standard does not recognize compressed backbone topologies as an acceptable implementation of telecommunications distribution except in limited circumstances as outlined below.*** The use of Compressed Backbone topologies shall be limited to the following applications:

*i.)* Specific Work Areas of the building with a high density of computer workstations such as computer or technology education laboratories. In this circumstance, alternate standards-compliant approaches supporting SNMP to the TO should be thoroughly investigated before a decision to implement a compressed backbone approach is made. Alternate approaches could include the following, depending on project-specific requirements.

a.) Standard star topologies as described elsewhere in this document, utilizing UTP and/or optical-fiber horizontal cabling to the individual TO.

b.) The use of cabinet-mounted "intelligent" electronics and a true backbone-to-horizontal cross-connect (or interconnect) within or in close proximity to the Work Area. This local connecting point could be accomplished by the use of jumper cables in lieu of patch cords where move-add-change management is not critical. (This approach would typically not be cost-effective for limited-area applications.)

c.) Where a large amount of flexibility in the work area is required due to frequent reconfigurations, consideration may be given to the use of consolidation points or multi-user telecommunications outlet assemblies installed within the horizontal distribution system. Installation shall be in accordance with EIA/TIA Technical Services Bulletin TSB-75: *Additional Horizontal Cabling Practices for Open Offices.*

d.) Where there is a desire to "future-proof "a system, consideration could be given to running "dark" (unterminated) optical fiber as a supplement to the horizontal cabling during initial construction. (Several school systems have utilized this approach.)

e.) Wireless Local Area Network (WLAN) applications.

***ii.)*** Remote applications such as portable classrooms (which are beyond the scope of this standard), small on-campus buildings or other outdoor facilities (i.e., stadium press box, outdoor environmental education area, etc.).

**C. Requirements:**

***i.)*** Termination hardware shall be located in a lockable cabinet installed in an accessible location within the Work Area. Cabinets shall be of sufficient size to accomodate system maintenance, future replacement of electronics and appropriate wire management. Termination hardware shall meet or exceed the same performance specification requirements as the horizontal cabling system. All cabling shall be located in appropriate wireways.

***ii.)*** Labelling shall meet the requirements of **4.6.**

***iii.)*** A duplex telecommunications power receptacle shall be provided at the cabinet location.

## 4.10.3 Premises Wireless Local Area Networks (WLAN)

**A. Definition:** As defined in these MSDE standards, premises Wireless LAN refers to implementation strategies that utilize narrowband (infrared) or spread-spectrum radio transmission technology as a replacement for, or supplement to, the horizontal cabling system. In a typical installation, the individual workstation is provided with a device that acts simultaneously as a Network Interface Device (providing Ethernet connectivity) and as a transmitter/receiver. The transmitter communicates via an infrared or radio frequency signal with one or more "Wireless Access Points" located in or near the work area. These access points are hardwired back to the building LAN cross-connects. Special Access Points can also serve as bridging devices to connect two LAN's within a building or between buildings (i.e., portable classrooms, etc.). Wireless Access Points hardwired to the building LAN are considered part of the building Telecommunications Distribution system for purposes of this MSDE Standard, interface cards for the individual workstation are not. **Note:** These systems are distinquished from wireless bridging technologies for Wide Area Network (WAN) applications, which are beyond the scope of this MSDE standard.

**B. Available Technology:**

*i.)* Infrared WLAN's operate in the 1-100THz frequency spectrum. The actual frequency is determined by the individual equipment manufacturer. Infrared systems are usually line-of-site and may be sensitive to objects blocking the transmission path and to atmospheric conditions. New transmission technologies have been developed to create multiple transmission paths by bouncing signals off wall and ceiling surfaces.

*ii.)* Spread-spectrum radio-frequency WLAN's currently operate in two frequency ranges - 902-928 MHz (the ISM or industrial, scientific, medical band) and 2.4000-2.4835 GHZ (low microwave ISM band). These systems send data signals by distributing them over a wide frequency band. This military-developed technology has been used for many years in critical communications and provides a high degree of signal security and reliability. Recent changes in FCC regulations will ensure that WLAN equipment operating in the 5 GHz range will become available in 1999. This proposed WLAN equipment is expected to offer more data throughput capability than is currently available (up to 25 Mbs vs. the current 1-2 Mbs).

**C. Application: Wireless solutions may be used as a supplement to the traditional "hardwired" approach where required. Wireless technology shall not be used as a complete substitution for a hardwired LAN due to cost and limitations on data throughput capability with currently available technology.** Typical acceptable applications may include spaces where fixed workstation locations are often difficult to accomodate (such as in laboratories), applications where "roaming" may be desirable, areas where hardwiring may prove unusually difficult or costly, for outdoor use, and in portable classrooms (portable classrooms are beyond the scope of this MSDE Standard)

**D. General Requirements:** Wireless equipment is to be UL Approved. Wireless systems shall meet the requirements of all applicable Federal Communications Commission (FCC) regulations and shall not require the Owner to obtain special site licences. Wireless systems shall also comply with applicable provisions of the wireless standards developed by the IEEE 802.11 committee for wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications. The use of systems allowing multi-vendor interoperability is encouraged. Wireless Access Points shall also fully support SNMP and the building network control standard.

**E. Installation Requirements:**

***i.)* Telecommunications Outlets:** For spaces in which a wireless solution will be implemented, a minimum of one (1) hardwired TO for data shall be provided, in addition to the required voice and video outlets, to support networked devices such as printers, etc. or portable wireless access points. This is in addition to any telecommunications wiring required to support permanent Wireless Access Point devices. **See also appendix A.**

> ***Designer's Note:***
> *One wireless implementation observed at the Camp Hill School District in Pennsylvania included the use of laptop computers brought to the classroom on a portable cart. The cart also included a wireless access point device to supplement the device permanently installed in the classroom. This supplemental device was plugged into an available hardwired outlet in the classroom, and increased the data throughput available to the classroom without the expense of permanently installing supplemental devices in each teaching station.*

***ii.)* Installation:** Access points are to be securely installed in an accessible location in or adjacent to the Work Area to be serviced. Where accessible ceilings are provided, an in-ceiling installation is preferable to avoid tampering, where allowed by code. Ceilings should be clearly marked with the equipment location where this approach is used. Access Points are to be provided in sufficient quantities and located so as to provide full transmission coverage of the required work area(s). All equipment and cabling is to be labeled in accordance with this MSDE Standard. Horizontal cable to the Access Point shall be Enhanced Category 5 UTP meeting the minimum transmission performance requirements of this MSDE standard.

## 4.10.4 Centralized Optical-Fiber Cabling

**A. Definition:** Centralized optical-fiber cabling is a distribution scheme in which each work area TO is directly connected, by means of optical-fiber cabling, to central ized network electronics located in the TER. In this arrangement, all the building electronics are located in the TER and the TC serves as only a cable pull through, splice or interconnect point. This arrangement is acknowledged by the ANSI/TIA/EIA-568A standard in TIA/EIA Technical Systems Bulletin TSB 72: *Centralized Optical-Fiber Cabling Guidelines.*

**B. Application:** At this writing, this topology is rarely utilized for K-12 school facilities due to cost, and is not the norm in the private sector except for more advanced business and scientific applications. However, due to the recognition that both technology and the costs of optical-fiber installation are subject to change, this MSDE Standard does not exclude centralized systems as an acceptable implementation. LSSs should recognize that this approach far exceeds the minimum standards outlined in this document.

**C. Requirements:** Centralized systems must comply with the requirements of TIA/EIA TSB 72. Note the following specific requirements:

***i.)*** The use of TCs is required.

***ii.)*** The use of an interconnect at the TCs, rather than a splice or pull-through is strongly recommended to maintain system flexibility, MAC management and scalability.

***iii.)*** The maximum horizontal cabling distance shall be as specified in Section 4 of TIA/EIA-568A.

***iv.)*** For 62.5/125 µm multi-mode cable, the combined length of the cabling (horizonatal plus backbone plus patch cords) between the TO and the centralized cross-connect shall be 984 feet (300m).

## 4.11 Recommendations for Work Area Cables

***The following is provided for informational purposes only and does not form a part of this Standard.***

Although outside the scope of this Standard, the following recommendations are for cabling practices within the Work Area (Equipment or Patch Cable).

The ANSI/EIA/TIA-568A Standard indicates certain maximum cable lengths for horizontal cabling. When developing this standard, EIA/TIA took into consideration the amount of cable which might be required between the TO and the individual computer workstations or Telecommunications Devices, as follows:

*For each UTP horizontal cabling channel, the maximum amount of work area equipment cable is specified as 3 meters (9.8 feet). Note that EIA/TIA TSB-75 allows for an increase in this length where the total length of the horizontal cabling is less than 265 feet (90 meters) in situations where consolidation points or multi-user Telecommunications Outlets are utilized. The maximum specified total amount of work area equipment cable and telecommunications closet patch cords, jumpers, etc. is specified as 10 meters (33 feet).*

To ensure that the individual workstation can take full advantage of the cabling infrastructure performance characteristics, it is strongly recommended that equipment cables utilized for connecting workstations and other telecommunications devices to the Telecommunications Outlets meet or exceed the performance requirements of the corresponding horizontal cabling distribution system.

# Part 5- Video Systems

## 5.1 Planning Considerations

**A. Overview:** This Section outlines additional requirements, recommendations and planning considerations for dedicated broadband video distribution systems. This section focuses on the importance of *preliminary planning, quality engineering and installation, and system documentation.*

- For Pathway and Space requirements for telecommunications systems, including video systems, **See Part 3**.
- For requirements regarding video system cabling requirements **See Part 4**.
- For information on the minimum number of Work Area Telecommunications Outlets for dedicated video **See Appendix A**.

**B. Codes and Standards:** Video distribution systems and the delivery of CATV signals are regulated by other government agencies. In addition, the requirements of local service providers can also mandate some of the details of video distribution system design. Both should be consulted when designing school video distribution systems. The design and installation of video systems shall fully comply with Federal Communications Commission (FCC) and Federal Aviation Authority (FAA) Regulations, including restrictions on building-level CCTV emissions. Installation shall also comply with the requirements of the National Television Standards Committee (NTSC).

**C. Changing Technologies:** Video technology is rapidly changing and is today perhaps the most dynamic of the telecommunications applications discussed in this MSDE Standard. The traditional distinction between video, voice, and data systems is becoming less defined, as all technologies begin to merge into single "multi-media" solutions. The move toward video sources such as DVD-ROM and the anticipated industry change-over to full digital broadcasting will accelerate this trend. However, at the present time the most cost-effective way to provide high-quality, multiple-channel educational video into the classroom remains with dedicated broadband video distribution systems. It is anticipated that this will remain true for a number of years. Therefore this section addresses the implementation of dedicated video-only systems. MSDE will continue to monitor this issue for further discussion in future editions of this document.

**D. Planning Considerations:** LSSs are encouraged to incorporate the following principles into video systems planning:

*i.)* **Statement of Need:** Early in the design process, establish a clear statement of video capabilities that would be expected of the completed video system. This statement should be very specific, and describe specific tasks that the user should be able to accomplish after installation of the video system in each type of instructional or administrative space. There should be a delineation between minimum requirements and optional requirements. Possibilities for future expansion should be addressed. *This step should be considered crucial to ensure that educational needs are met without unnecessary over-design of the video infrastructure.*

*ii.)* **Multi-disciplinary Approach:** Approach video system design as a multi-disciplinary issue. For example: video use in the classroom may require information on the educational requirements (specific tasks to be accomplished), types of monitors to be purchased (compatibilities, connections, screen size and image quality), computer workstations (if they are to be interfaced with the video system) and even computer operating system software (for information on video driver capabilities).

*iii.)* **Appropriate Technologies:** The planning process should emphasize the specification of *appropriate* technologies which accomplish the stated needs in the most efficient manner. Emphasis should be on the selection of systems incorporating simplicity (least number of components), flexibility (ability to change and expand the system), ease-of-use and low-maintenance.

**E. Quality Assurance:** The following basic requirements are necessary for a successful video systems implementation.

*i.)* **Engineering:** Selection of highly qualified specifiers and designers is mandatory. Emphasis should be on firms and individuals with extensive experience with video distribution design in the school environment and with a thorough knowledge of NTSC, FCC, BICSI, and TIA standards and guidelines. **Also see Part 2 - Quality Assurance.**

*ii.)* **Installation:** Selection of highly qualified installers is mandatory. Emphasis should be on firms and individuals with extensive experience with video distribution installation in the school environment. **Also see Part 2 - Quality Assurance.**

*iii.)* **Testing:** The entire video system should be rigorously tested before acceptance by the LSS. Testing requirements shall be thoroughly delineated in the project specifications. **See 5.7**

*iv.)* **Documentation:** Complete documentation of the entire system, including test results and installation "as-installed" is mandatory. **See 5.8**

*v.)* **Training:** Provisions for school system staff training shall be incorporated into all video system installation contracts. **See Part 2.4.**

## 5.2 Minimum Operational Criteria

**A. General:** Video systems shall be broadband systems operating at 5 MHz to 750 MHz (T-7 to channel 117 ultra-band), with a sub-split spectrum (5-50 MHz reverse direction/50-750 MHz forward direction to TO).

**B. Signal Strength:** Video systems shall provide a signal strength of 0-10 decibels for all frequencies (100 microvolts at 75 Ohms) at the TO when all outlets are at 100% capacity.

**C. Centralized Distribution:** The premises video system shall be capable of receiving multiple video programming signals from a variety of outside sources at the TER and distributing these signals on multiple broadband channels to each video outlet in the school. Outside programming sources may include cable television (CATV), master antenna television (MATV), satellite downlink (C and/or KU-band), microwave and/or instructional television fixed service (ITFS), depending on LSS need and available resources. Capability shall also be provided for distributing local programming generated on-site from centralized sources such as VCR's, laserdisc, DVD-ROM, CD-ROM, computer, video camera or video file server.

***Designer's Note:***
*This above requirement is not intended to infer that centralized distribution shall be required as the primary means of distributing instructional television programming to the classroom, merely that some centralized capability exist. The degree to which centralized distribution is implemented is at the discretion of the LSS. Decentralized methods of delivery, such as classroom video cassette or DVD players are an acceptable method for the primary delivery of pre-recorded programming to the classroom. Decentralized methods such as this are economical and give the instructor full control of the media.*

**D. Bi-directional Capability:** The video system shall be designed (signal-balanced) so as to provide signal origination capability from each work-area video outlet. The school staff and students should be able (with the use of appropriate work-area devices such as a camera and modulator) to transmit a video signal from any video outlet in the facility to the rest of the facility.

**E. Work-Area Control:** The video infrastructure shall provide the teacher with the ability to control video devices within the classroom including on/off, volume and program selection.

**F. Accessibility:** The video infrastructure shall have the capability of supporting adaptive technology to support students and staff with special needs.

**G. HDTV:** Systems installed in accordance with this section will be capable of transmitting High Definitive Television (HDTV) signals. School systems should note that some work area equipment such as monitors and VCR's may not be compatible with HDTV signals and may require decoder equipment at the device. As HDTV replaces analog video, more HDTV compatible equipment will become available.

## 5.3 Transmission Media

**A. System Options:** Video distribution may be implemented over coaxial, UTP copper or optical-fiber systems.

***i.)*** **Coaxial Systems:** At this time, coaxial systems are the most common and typically the most cost-effective implementation. They are based on time-proven technology and, properly designed and installed, can provide reliable long-term service. However, they require high-quality design engineering in order to function effectively (particularly with bi-directional capability) and, installed in a typical "tap and drop" topology, they can be difficult to troubleshoot and maintain.

***ii.)*** **UTP Copper systems:** UTP systems are now available and are undergoing rapid improvement. They typically involve a star-wired topology utilizing CAT 5 wiring (like data systems), have a "plug and play" ease of installation and use, and are very easy to modify and troubleshoot. The use of new Enhanced CAT 5 cabling promises a large bandwidth capability. However, at this time, the most successful systems tend to use proprietary equipment and standards, and can be relatively expensive when compared to typical coaxial systems.

*iii.)* **Optical-fiber systems:** Optical-fiber systems are usually limited to dedicated multi-media distance learning facility installations at this time and are not yet considered a cost-effective solution for whole-building video implementation due to very expensive connectivity requirements (fusion splices, etc.). Single-mode optical-fiber cable is occasionally used as an alternative interbuilding video backbone cable, although this is rare in K-12 facilities.

**B. Recommendation:** Due to cost, many school systems will continue to utilize coaxial distribution systems for the near future. Due to rapidly changing technology, LSSs are advised to review all available options, in consultation with their design professional and the vendor community. Consideration should be given to system capabilities, ease of use, initial capital cost, long-term cost, system management, maintenance, and upgrading capability.

## 5.4 Topology

**A. Options:** These MSDE Standards require the use of a star-wired topology for all telecommunications systems **(See Part 4)**. All UTP and Fiber-optic video implementations shall utilize a star-wired topology. This section discusses the use of a "tap and drop" topology as an alternative *for coaxial systems only*:

*i.)* **Star-wired topology:** Two main features of star-wired topologies include centralization of all network equipment and hardware (for ease of maintenance and troubleshooting), and the use of patch-panel management or cross-connects (for system MAC management). The EIA/TIA-568A Standard recommends the use of this topology for all telecommunications distribution. Star-wired topologies for video distribution can be relatively expensive, when compared to "tap and drop", and can be challenging to engineer in a cost-effective way due to signal-strength and cabling limitations associated with the long home-runs required in some facilities (up to 295ft. max.). Despite these limitations, star-wired topologies remain the preferred "first-choice" as a long-term building implementation due to ease of maintenance and more flexible MAC management. Several LSSs in Maryland have standardized on this method for these reasons.

*ii.)* **Tap-and Drop topology:** The most common video-distribution topology is the tap and drop method. As the name implies, tap and drop utilizes a looped high-capacity backbone (trunk) cable emanating from the distribution closets. TOs are connected to the main trunk cable by horizontal cabling which is "tapped" into the trunk at multiple locations along it's length, utilizing passive devices such as taps, couplers and/or splitters. Bi-directional broadband line and distribution amplifiers and other balancing equipment such as in-line equalizers are located where required to ensure adequate video signal at the outlets.

The "tap-and-drop" approach incorporates the most efficient use of cable, often requiring much less cable than the home-run requirements of a star topology. Properly engineered and installed, these systems can provide a high quality video signal to the work area. The main criticism of this approach involves maintenance and MAC management. It can be more difficult to isolate faulty components in a tap and drop configuration. It is more difficult to inspect installation. Because most of the taps and other distribution components are located in concealed locations (such as above ceilings), it can be difficult to work on, or even find, components which require maintenance, particularly in systems which are not well documented.

**B. Recommendation:** The recommendation on the most appropriate system configuration for a particular project revolves on the issue of Initial Cost vs. Long-Term Management. Each school project will present unique challenges which will effect the appropriateness of a particular solution. Therefore, the most appropriate coaxial topology for a specific school project is at the discretion of the LSS, and should be determined by a thorough review of the issues discussed above, the requirements of local service providers and existing contracts (if any), and in consultation with the project design professional. Preference shall be given toward star-wired systems, with "tap and drop" utilized as an alternative where necessary and if in alignment with the requirements of the LSS. It is recommended that a cost analysis for both approaches become an essential ingredient in the design process to assist in informed decision making.

# 5.5 Work Area Considerations

**A. Overview:** As the purpose of the video distribution system is to support the educational program, a clear understanding of the needs of the school educator is required before implementing a systems design. The following is a brief discussion of issues regarding the implementation of video in the classroom and other work areas.

**B. Planning:** In order to ensure that the most appropriate video systems are installed, it is critical to list all the anticipated requirements at the beginning of the design process. Failure to document these requirements can lead to either inadequate infrastructure or over-specification of the infrastructure. The project educational specification should clearly state the methods by which video will be utilized in the work area. These requirements should be more clearly defined as the project proceeds through Schematic Design and Design Development.

**C. Classroom Video Capabilities:** The following capabilities are often being incorporated into Maryland's classrooms. A single classroom may require a few, or all, of the following capabilities shown in **Figure 5-1**. Each type of use can have a profound impact on the design details or cost of the video distribution system. It is therefore important that the needs for a particular project be carefully defined early in the design process.

**Figure 5-1**
Video Use in the Classroom

***i.)*** Reception of CATV or other programming originating from outside the school facility.
***ii.)*** Reception of pre-recorded programming (Tape ,Video Disc, etc.) originating from a central location within the school facility (usually the media center).
***iii.)*** Reception of pre-recorded or live programming originating from other classrooms and work areas within the facility, including from a school television studio.
***iv.)*** The viewing of pre-recorded programming originating from a source within the classroom.
***v.)*** The viewing of live demonstrations broadcast from within the same work area (For example: images from science classroom microscopes or other demonstrations projected onto overhead video monitors.)
***vi.)*** The ability to broadcast live or pre-recorded programming to other areas in the building.
***vii.)*** The ability to utilize video monitors for classroom demonstrations generated on a computer workstation within the classroom.

**D. Classroom Video Monitors and Projection Units:** Although requirements for the video monitors and/or video projection units are beyond the scope of this MSDE Standard, an understanding of the monitor placement and specification is critical to the designers ability to configure an effective distribution system. In addition, inappropriate attention to the planning and specification of the monitors can limit the usefulness of the video system in the classroom despite installation of a high quality video infrastructure. The following is a brief discussion on planning considerations for video monitors in the classroom.

*i.)* **Screen size and image quality:** The appropriateness of a particular monitor to a specific classroom use must be carefully matched. Video monitors are typically used for whole-classroom instruction and therefore must be sized appropriately to ensure visibility to all students. A monitor screen size of 27" (diagonal) is usually considered a minimum for classroom instruction. Classroom uses which anticipate a significant amount of text display must place a high priority on larger screen size, high image quality and correct placement.

*ii.)* **Quantity and Location:** Many LSSs have standardized on a preferred method for locating video monitors in a typical classroom. Most use a permanent mounting system in which the monitor is installed on a wall (or ceiling) mounted bracket and located in a corner of the primary teaching wall, while many school systems prefer to locate monitors on a movable cart. Both methods will have an influence on the location and wiring of the video outlets and on students ability to view the screen. Often, in large teaching spaces such as laboratories (Science, Technology Education, Family and Consumer Sciences, etc.), one monitor is not enough to provide adequate coverage to all students in the classroom, particularly for presentations involving text and other fine detail. For these spaces, more than one monitor may be required, depending on room configuration. Consideration should be given to reducing the effects of screen glare from windows and other light sources. Careful attention should also be given to wall and ceiling mounted monitors to ensure that teaching staff can reach the equipment controls, and to ensure a minimum of 6'-8" headroom in areas of foot traffic.

*iii.)* **Monitor Specifications:** The specifications of the particular monitor to be purchased should be developed in consultation with the video systems designer to ensure compatibility with the building video infrastructure and to ensure that the infrastructure can fully support the monitors capabilities. See **Classroom Video Outlets** (below) for further discussion.

**E. Classroom Video Outlets:**

***i.)* Number and Location: Appendix A** indicates a requirement for two (2) video outlets per classroom in a "high-low" configuration. This requirement applies to classrooms containing one monitor in which the monitor is wall or ceiling mounted, and may be modified as described below. In this configuration, the "high" outlet would be located adjacent to the monitor and the "low" outlet would be located at a more convenient elevation to be utilized for video input and connection to computer workstations (where required). This low outlet is generally located adjacent to the teacher workstation. An acceptable alternative adopted by one school system is to provided a single cluster of outlets located in a common box at 48" above the floor. The number and location of outlets should be carefully considered based on the number of monitors in the classroom, the most appropriate monitor location for classroom viewing, and the type of interfacing required between the monitor and other work area devices such as VCR's and computer workstations.

***ii.)* Outlet configurations:** The amount and type of video and audio connectors provided at the video faceplate will vary depending on the type of equipment utilized, the anticipated use and the desired quality of output. Where it is anticipated that the video monitor will need to interface with other work area devices (particularly computer workstations), careful attention must be paid to the details of the equipment specifications and the desired capabilities. For example, when providing the capability for interfacing video monitors with computer workstations, the following issues may need to be addressed by the video systems designer:

**a.)** Classroom monitor type: NTSC video? MultiSync VGA?

**b.)** Types of input connections available on the monitor: Y/C, Composite, VGA with internal scan conversion, MultiSync VGA, Audio? Is a loop-through VGA return required or available?

**c.)** What is the type of computer workstation? Is the operating system capable of supporting two VGA cards (allowing the resolution for both monitors to be set independently)?

**d.)** Can acceptable results be achieved using external VGA to Y/C scan conversion (to an NTSC monitor lacking VGA input)? With an external distribution amplifier (to an NTSC monitor which has VGA input with internal scan conversion)?

**e.)** In addition to the computer interface, what other connections may be required? Low RF (for portable video and future HDTV display at the workstation)? A local composite video (RCA) connector?

**f.)** What are the anticipated cable lengths between the computer workstation and the monitor and the resulting effect on performance?

**g.)** Must all interfacing between the monitor and the workstation be through intermediate outlets (cabling in conduit) or is some exposed cabling acceptable for short-term use?

Only by gaining a clear understanding of issues such as the above can an experienced video distribution system designer recommend the appropriate configuration for video interfaces. The LSS should be prepared to coordinate with the designer on the above issues.

***iii.)*** **Spare Pathways:** Due to the changing nature of video technology, it is strongly recommended that spare video cable pathways be provided within the classroom to accommodate future upgrades or modifications. Where it is anticipated that computer workstations will interface with video monitors through intermediate video/audio outlets, it is recommended that backboxes and faceplates be sized for spare capacity. A spare conduit and pull cable should be installed between the two interface points within the classroom.

## 5.6 Above-Ceiling Devices

**A. Installation considerations:** In addition to the requirements of **Parts 3 and 4**, the following installation practices shall apply to video systems which incorporate distribution devices installed above ceilings or in other limited-access areas:

***i.)*** No video system distribution devices (such as taps, couplers, splitters, etc.) shall be located in inaccessible ceiling spaces. Installation above ceilings constructed of removable Acoustical Ceiling Tiles (ACT) in a suspended grid is acceptable.

***ii.)*** Devices shall be located clear of adjacent mechanical devices (ducts, pipes, etc.), conduit and building structure to provide for maintenance access.

***iii.)*** Devices shall be independently supported with mechanical connectors (not cable ties) from the building structure so as to provide no strain on the cabling connections.

*iv.)* Cables shall be independently supported from the building structure, or installed in appropriate pathways such as cable trays. Cables are not to be suspended from other cable, ceiling support structure, mechanical or electrical devices.

## 5.7 Testing and Acceptance

**A. General Requirements:** All cables and termination hardware and system electronics shall be 100% tested for defects in installation and to verify conformance with performance specifications under installed conditions. Any defects in the distribution system shall be corrected prior to system acceptance. All test results shall be thoroughly documented for the project record.

**B. Project Specifications:** Project specifications shall prioritize system testing. The design engineer shall provide detailed specifications for the tests and test procedures to be employed for the specific project. The recommended format includes the following components for each required test:

- The type of test to be performed
- The objective of the test
- Recommendations or requirements on testing devices and settings to be used
- A detailed testing procedure, including recording requirements

**C. System and Component Testing:** The actual tests to be performed for a particular project should be determined by the design engineer based on project specific requirements. The following tests may be required:

- Overall system frequency response
  - Power supply to active equipment
  - Amplifier Balancing
  - Forward system levels at the outlet (or tap)
- Return system levels
- Forward and Return Frequency and Peak-to-Valley response
- Forward and Return Carrier-to-Noise Ratio
- Forward and Return Carrier-to-Hum modulation
- Forward and Return Carrier to Second and Third Order Beat
- System Shielding Effectiveness

## 5.8 Video System Labeling and Record Documents

**A. Overview:** Basic requirements for system labeling are described in **Part 4.6.** Basic requirements for system record documents are described in **Part 4.8.** This section describes additional requirements for video distribution systems, particularly for "Tap-and-Drop" topologies.

**B. Record Drawings:** Record drawings shall *accurately* show the locations for all above ceiling distribution components including, but not limited to, taps, splitters, combiners, in-line amplifiers and equalizers.

**C. Ceiling Identification:** The location of all video system components located above ceilings shall be identified by applying an identification marker or label to the ceiling grid directly below the device location. A phenolic label with a device identification number or other similar marker is recommended.

## 5.9 Warranties

**A.** A minimum two (2) year performance and installation warranty is recommended for the entire video distribution system. Note that a comprehensive manufacturers performance warranty of the type described in Part 4 for data networks is not available at this time for coaxial-based video systems.

# Part 6- Building Electrical System

## 6.1 Overview

The building electrical system is to be designed to accommodate telecommunications. Special consideration shall be given to the provision of *adequate quantities* of electrical power, *power quality*, and *reliability*. This includes the provision of dedicated panels and circuiting for serving the telecommunications equipment, special provisions for grounding and bonding, considerations for the reduction of common-mode noise and the provision of uninteruptable power supplies for critical equipment.

## 6.2 Codes

The building electrical system shall be designed and installed in conformance with all applicable codes, including the requirements outlined in NFPA-70, National Electrical Code (NEC).

Reference is also made to IEEE Std. 1100-1992 (or latest version): *IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.*

## 6.3 Qualifications

**A. Designer Qualifications:** All electrical design shall be done by a professional engineer registered in the State of Maryland. Other State or Local qualification requirements may apply.

**B. Installer Qualifications:** Installation work shall be accomplished by an appropriately experienced electrical contractor licensed to practice in the local jurisdiction having authority at the school location. Other State or Local qualification requirements may apply.

## 6.4 Existing Facilities

**A. Electrical System Assessment:** Where technology upgrades are to be incorporated into existing facilities, the existing electrical infrastructure must be assessed by a qualified electrical engineer to determine the adequacy of the existing electrical systems to accommodate the proposed upgrades. It is recommended that the following items be considered in this assessment:

*Electrical Capacity*
*Electrical Equipment Serviceability*
*Segregation of electrical loads*
*Wiring and grounding of existing electrical panels and transformers*
*Steady State power analysis*
*Transient power analysis*
*Equipment protection (surge protection, uninteruptable power supplies)*
*Thermographic imaging of existing electrical equipment*

**B. Recommendations:** Based on an analysis of the above information, the electrical engineer should provide recommendations for upgrading the existing electrical infrastructure as required to accommodate the minimum requirements outlined in this section.

## 6.5 Isolated Grounding

**A. Isolated Ground Receptacles:** See **Parts 3.5.5 and 3.6.6** for additional electrical requirements, including isolated ground receptacles for the TER and the TCs.

## 6.6 Work Area Power Receptacles

**A. Quantity:** A minimum of one dedicated duplex power receptacle shall be provided for each Work Area TO.

> ***Designer's Note:***
> *Additional non-dedicated receptacles should be provided for non-telecommunications use in quantities as required. These additional receptacles are beyond the scope of this Standard.*

**B. Location:** Power receptacles shall be located within six (6) feet of the associated TO.

**C. Identification:** Power receptacles dedicated for Telecommunications use shall be clearly identified as such by means of color coding or text.

***Designer's Note:***
*The use of orange Isolated Ground (IG) receptacles simply as a means of identifying receptacles for the use of Telecommunications Equipment is not permitted, except where the circuit is truly wired in an isolated ground configuration, with an additional insulated ground conductor.*

## 6.7 Work Area Branch Circuiting

**A. Branch Circuits:** One 20A, 120V, 1-phase branch circuit shall be provided for each four (4) work area duplex power receptacles. Each branch circuit shall consist of a phase, neutral and insulated ground conductor in metallic conduit, and shall have its own 20A circuit breaker in an electrical distribution panel dedicated to serving Telecommunications Equipment.

## 6.8 Distribution Panels

**A. General:** An appropriate number of three-phase 208/120V electrical panels shall be dedicated to supply the needs of the building Telecommunications systems. Both the neutral bus bar and the neutral conductor serving the Telecommunications Distribution Panels shall be sized for double the capacity of the phase conductors to accommodate neutral current present due to high concentrations of electronic load. These panels shall also contain an equipment grounding bus bar on which all equipment grounding conductors are terminated.

**B. Identification:** All branch circuits are to be identified on the distribution panel directory.

**C. Emergency Power:** Where the building is provided with emergency power generators, it is recommended that Distribution Panels serving critical telecommunications equipment (i.e., distribution equipment, file servers, etc.) be included in the emergency power distribution scheme. This is not intended to substitute for the necessary UPS backup on these same systems.

**D. Isolated Ground:** See **Parts 3.5.5 and 3.6.6** for isolated ground requirements for the TER and the TC receptacles.

## 6.9 Transformers

**A. General:** Transformers shall be designed and installed so as to provide appropriate voltage regulation and reduction in common-mode noise for the telecommunications systems. An appropriate number of 480-208/120V delta-wye transformers, each with its associated 208/120V dedicated electrical panel (see above) shall be used to supply Telecommunications equipment. Transformers shall be placed as close to the load as possible. Transformers with interwinding Faraday shields may be utilized to further improve the noise immunity of the system.

**B. Size:** Electronic equipment creates non-linear currents in the electrical system. Transformers serving largely electrical load shall be sized to accommodate that current. ANSI/IEEE C57.110 defines the criteria for derating the transformer capacity based on the harmonic content of the load. An alternative to over-sizing a standard transformer is the use of a "K" factor transformer which is designed to accommodate a non-linear load.

**C. Bonding:** A neutral-to-ground bond shall be established on the transformer secondary. This bond shall be connected to the transformer enclosure, and to the building grounding electrode system, which includes the structural steel or the nearest available grounded water pipe. (NEC Article 250-81).

## 6.10 Grounding and Bonding Infrastructure

**A. General Requirements:** The building shall be provided with a telecommunications grounding and bonding infrastructure designed and installed in accordance with applicable codes and the latest version of ANSI/TIA/EIA-607, *Commercial Building Grounding and Bonding Requirements for Telecommunications*, including requirements for sizing, color coding and labeling. The Grounding and bonding infrastructure is composed of five major components **(Also see Figure 6-1):**

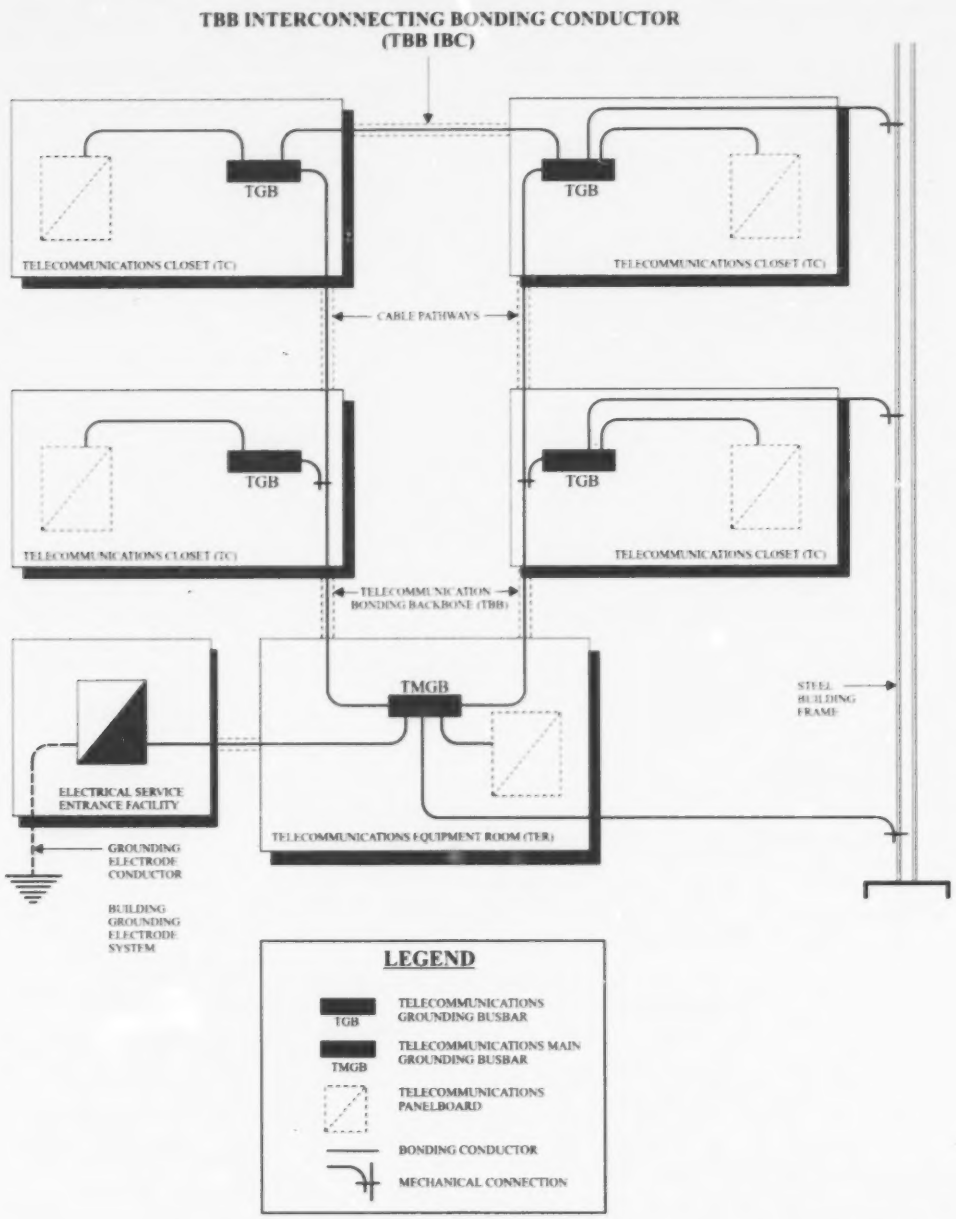
*i.)* **Bonding Conductor for Telecommunications**: Interconnects the telecommunications bonding and grounding infrastructure, through a TMGB, to the building service equipment ground.

*ii.)* **Telecommunications Main Grounding Busbar (TMGB):** A copper busbar which serves as the main interface point between the telecommunications bonding and grounding infrastructure and the building service equipment ground. It serves as the termination point for the Telecommunications Bonding Backbone (TBB) and is interconnected to the building service equipment ground by the Bonding Conductor for Telecommunications. It is preferably located in the Telecommunications Entrance Facility (TEF), (usually the TER), and also serves as the grounding busbar for the TEF.

*iii.)* **Telecommunications Bonding Backbones (TBB):** Insulated copper conductors connecting the Telecommunications Grounding Busbars (TGB) to the TMGB.

*iv.)* **Telecommunications Grounding Busbar (TGB):** A copper busbar provided in each TC which serves as the main grounding connection for telecommunications systems and equipment in that area. It is connected to the TMGB through a TBB, and may be connected to other TBB's through a Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC).

*v.)* **Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC):** An insulated copper conductor which connects the TBBs.




# SAMPLE DIAGRAM
# TELECOMMUNICATIONS GROUNDING AND BONDING SYSTEM

**FIGURE 6.1**
**(ADAPTED FROM EIA/TIA-607, FIGURE 2.1-1)**



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# Glossary

***The following are brief definitions for some of the terms utilized in this MSDE standard. More specific and extensive glossaries for a particular subject can be found in the documents listed in the References section.***

**µm** - (symbol) - Micron or micrometer. One millionth of a meter.

**10BaseT -** 10 Mbps implementation of Ethernet over UTP cable.

**10BaseF** - 10 Mbps implementation of Ethernet over fiber-optic cable.

**100BaseT -** 100 Mbps implementation of Ethernet over UTP cable. Sometimes referred to as "Fast " Ethernet.

**100BaseF** - 100 Mbps implementation of Ethernet over fiber-optic cable.

**1000BaseT -** Proposed 1000Mbps (or "Gigaspeed") implementation of Ethernet over four-pairs of UTP.

**ACR** - Attenuation to Crosstalk Ratio. A primary method of expressing the transmission performance characteristics of a channel or component.

**ADA** -Americans with Disabilities Act; See **References.**

**ADAAG** -Americans with Disabilities Act Accessibility Guidelines; See **References.**

**ANSI** - American National Standards Institute

**ATM** - Asynchronous Transfer Mode. A switching protocol designed for multi-media (data, voice and video) transmission.

**Backbone** - In a hierarchical star wiring topology, the telecommunications distribution system components (cabling, pathways, connecting hardware, etc.) linking the horizontal cross-connects to the main cross-connect. More commonly, "backbone" refers to the various cables which connect the Telecommunications Closets to the Telecommunications Equipments Room. In video systems using a tap and drop topology this typically refers to the main trunk cable.

**Backbone Pathways** - Building telecommunications pathways pertaining to the backbone cabling system (i.e.: typically between the Telecommunications Closets and the Telecommunications Equipment Room (TER), between the TER and the Telecommunications Entrance Facility and between the main building and other satellite buildings on the same campus. See Telecommunications Pathways below and **Parts 3.3 and 3.4.**

**Bandwidth -** A specified frequency range used for identifying the electrical transmission capabilities for components and systems, typically expressed in millions of Hertz per second ( MHZ). The bandwidth capabilities of a system are determined by the system electronics, cabling media and other components, and the quality of the installation. Bandwidth is an electrical specification and is not the same as data rate, although the two are interrelated. See **Data Rate.**

**BICSI** - (Formerly Building Industry Consulting Service International). An international telecommunications industry organization which is composed primarily of designers, installers and manufacturers involved with telecommunications infrastructure design and implementation. BICSI offers extensive training and certification programs and produces technical manuals on the implementation of telecommunications systems. See **References.**

**BOCA** - Building Officials Code Administrators. The national organization responsible for the development of the BOCA National Building Code. See **References.**

**Bridge** - A device which connects two Local Area Networks.

**Broadband** - (For video systems). A multi-frequency simultaneous broadcast delivery system.

**Cabling -** (Also commonly referred to as "telecommunications wiring"). The primary transmission media for the distribution of building-wide telecommunication services. Building cabling may include a combination of various copper and/or optical-fiber based media.

**Campus -** A collection of school buildings on the same property.

**Coaxial cable -** A type of shielded copper cabling, commonly used for broadband applications such as video distribution, typically consisting of an insulated single copper conductor (twinaxial cable uses two) encased in wire mesh.

**COMAR** - Code of Maryland Regulations; See **References.**

**Cross-connect** - A facility which allows both the termination and interconnection and/or cross-connection of telecommunications cabling systems so as to allow flexibility in the management of cable moves adds and changes, usually accomplished by the use of jumper cables or patch cords.

**Data Rate -** The number of binary digits (bits) transferred per unit of time, typically specified as bits per second or millions of bits per second (Mb/s), for a given bandwidth. Data transfer rate is not the same as bandwidth but is interrelated. Data rate is dependent on the given bandwidth, the application and the encoding scheme of the signal. The following chart indicates the data rates for some typical data network control schemes.

| Control Standard | Data Rate | Min. Signal Bandwidth | Wire Pairs |
|---|---|---|---|
| Ethernet | 10 Mbps | 10 MHZ | 2 pair |
| Fast Ethernet | 100 Mbps | 62.5 MHZ | 2 pair |
| Gigabit Ethernet (proposed) | 1000 Mbps | 62.5 MHZ | 4 pair |
| ATM (155 Mbps) | 155 Mbps | 77.5 MHZ | 2 pair |

**Demarcation Point (Demarc)** - The interface point between outside utilities entering the building (such as telephone, CATV, WAN cabling, etc.) and the building telecommunications system. Requirements for Demarcation Points for certain utilities, including their location, may be governed by other local, state or federal agencies (such as the FCC), and/or requirements imposed by the servicing utility.

**Drop** - One or more (typically two or more) horizontal cables run in a common pathway and terminating in separate Telecommunications Outlets, usually in a common faceplate.

**EIA** - Electronic Industries Association.

**Electromagnetic Interference (EMI)** - Radio frequency interference created by electrical currents in all electrical and electronic components, including copper cabling, which can cause errors in data transmission when not adequately controlled.

**Electronic Industries Association (EIA) -** An international association which establishes industry standards for telecommunications infrastructure in partnership with the Telecommunications Industry Association (TIA). See **References.**

**Enhanced Category 5 -** At this writing, a proposed TIA/EIA UTP copper cabling specification currently outlined in TIA/EIA Standards Proposal SP-4195 (*Proposed addendum No. 5 to TIA/EIA-568A: Transmission Performance Specifications for 4-pair 100 Ohm Enhanced Category 5 cabling).* This standard is expected to be ratified by TIA/EIA and issued as an addendum to the 568A standard in the spring of 1999. These performance specifications allow additional "headroom" over the standard Category 5 specification for the support of transmission standards requiring up to 100 MHZ of bandwidth (including the proposed 1000Mbps Ethernet standard), by providing superior attenuation and cross-talk performance.

**Entrance Facility** - For purposes of this MSDE standard, a building space containing the point at which outside building telecommunications services (such as telephone, CATV, WAN connections, or interbuilding cabling etc.) enter the building. This space may also contain a grounding connection and Demarcation Points for these utilities. It is recommended that the telecommunications entrance facility be located in the Telecommunications Equipment Room. However, applicable statutory requirements of other government agencies, or the requirements of the providing utility, take precedence over this requirement. Requirements for entrance facilities are included in the ANSI/TIA/EIA-568A and 569 standards.

**Ethernet** - Common term for the Carrier-Sense Multiple Access with Collision Detection (CSMA/CD) network control standard defined in IEEE 802.3. It is a highly reliable, widely supported and flexible network access control, and has been adopted as a standard by all of Maryland's 24 school systems. IEEE 802.3 defines several variations of Ethernet for transmission rates of up to 100Mbps on copper or optical-fiber based systems. At this writing, standards for 1000Mbps ("Gigabit" or "Gigaspeed") Ethernet are currently under development.

**FCC** - Federal Communications Commission. An Agency of the Federal Government which regulates the broadcasting industry, including establishing limits on EMI emissions for electronic devices and transmission systems and regulating the use of the radio-frequency spectrum (licensing, frequency assignments, etc.) See **References.**

**FDDI** - Fiber Distributed Data Interface. A networking standard, specified by ANSI (X3T12), developed for use on optical-fiber networks.

**Fiber-optic cable** - See optical-fiber cable.

**Firestopping** - Materials and methods for maintaining the integrity of building fire-separations (fire-rated walls, floors, etc.) where they are penetrated by building utilities such as telecommunications cabling and conduit. Requirements are outlined in the applicable building codes. Acceptable materials and methods are to be as tested and certified by UL or other testing agencies. **See Part 3.7.**

**GHz** - Gigahertz (1 GHz=1 billion hertz)

**Hertz (Hz)** - International unit of frequency (1 hertz=1 cycle per second)

**Hierarchical Star Topology** - An expanded version of the physical star topology in which intermediate (horizontal) cross-connects are introduced between the Work Area Telecommunications Outlets and the Main Cross-Connect. **See Part 4.1.3**.

**Horizontal Cross-Connect** - A cross-connect between horizontal cabling and another cabling system (such as backbone or equipment cabling or another horizontal cabling system).

**Horizontal Pathways** - Building telecommunications pathways pertaining to the horizontal cabling system (i.e.: typically between the Work Area Telecommunications Outlets and the Telecommunications Closet). See Telecommunications Pathways below and **Part 3.2.**

**Hz** - Hertz.

**HVAC**- Heating Ventilation and Air Conditioning systems and components.

**IEEE**- Institute of Electrical and Electronic Engineers. An international association which establishes industry standards for the more commonly accepted network control standards; See **References.**

**Infrastructure** - For purposes of this standard, telecommunications infrastructure refers to those building components which are installed to support building-wide telecommunications services. This typically includes the telecommunications outlets, cabling, connecting hardware, routing electronics and installation components.

**Intrabuilding** - Between points in the same building.

**Interbuilding** - Between buildings.

**Interconnection** - A connection scheme which provides a direct connection between cabling systems without the use of patch cords or jumper cables.

**Isolated Ground** - An electrical grounding strategy designed to reduce the influence of common-mode noise created by non-linear currents in the building electrical system which are often created by electronic devices. Isolated grounding is required for telecommunications equipment rooms and telecommunications closet power supplies. **See Parts 3.5.5 and 6.**

**Jumper Cable** - A relatively short section of cable, without end connectors, used for connecting telecommunications circuits across a cross-connect. Jumper cables are generally not as flexible as patch cords (used for the same function) due to the lack of end connectors.

**Local Area Network (LAN)** - A data network that is limited in scope and geographical area, typically serving one school building or facility.

**LEA** - See LSS

**LSS** - Local School System (often used interchangeably with LEA - Local Education Authority). Any one of Maryland's 24 public school systems, representing each County and Baltimore City.

**MAC Management** - The ability to Move-Add-Change the system configuration over time. This is facilitated by the use of hierarchical topologies and a system of cross-connects. MAC may also refer to Media Access Control when discussing network control standards (this definition not used in this document).

**Maryland Plan for Technology in Education 1999-2003 -** A plan for the implementation of Educational Technology in Maryland's Public Schools which was developed for the State Board of Education by the Maryland Business Roundtable for Education, Committee on Technology in Education. See **References**

**Mb/s** - (Also Mbps) Megabits per second. A data transfer rate (bit rate) of 1 Mb/s=1 million bits per second.

**MHZ** - Millions of Hertz or "Megahertz" (1 MHZ=1 million hertz). An electrical term used for specifying the bandwidth capacity of a particular telecommunications channel.

**MSDE -** Maryland State Department of Education

**NFPA** - National Fire Protection Association. The national organization responsible for the development of a number of codes which are applicable in Maryland, including ANSI/NFPA 101 *Life Safety Code* and ANSI/NFPA 70 *National Electric Code*. See **References**.

**NTSC** - National Television Standards Committee. National committee which establishes criteria for video systems such as signal quality, strength, and delivery mechanisms.

**Ohm** - Unit of electrical resistance.

**Optical-fiber Cable** - (Also commonly referred to as fiber-optic cable). A transmission media, offering high data transmission capability, which is comprised of glass or plastic fibers encased in a protective cover. Signal transmission is by the use of a modulated light-wave signal typically generated by either a Light Emitting Diode (LED) or laser light source. Specialized electronics at end terminations are required to execute the conversion between light and electrical signals.

**Owner** - Local School System.

**Patch Cord -** A relatively short length of telecommunications cable, provided with connectors on one or both ends, used for connecting telecommunications circuits across a cross-connect.

**Patch Panel** - An electronic device consisting of a field of connectors and modular jacks used to facilitate an interface point (cross-connect) between building horizontal and backbone cabling systems and network electronics. Patch panels are designed to facilitate Move-Add-Change management of the building cabling system.

**Pathways** - See Telecommunications Pathway

**Plenum** - An isolated building space, typically above a ceiling, utilized as a pathway for the distribution or collection of environmental air (heating, ventilating and/or air conditioning) without the use of ductwork. For life safety reasons, building codes place requirements and restrictions on building utilities (such as telecommunications cabling) which pass through plenum spaces. In general, the use of plenum air distribution systems is strongly discouraged in Maryland's public schools for indoor air quality (IAQ) reasons.

**PSCP** - Maryland's Public School Construction Program.

**Public School Construction Program** - As provided for in the Education Article of *The Annotated Code of Maryland*, a program of State funding for eligible public school construction and capital improvement projects which is administered by the State Board of Public Works through the Interagency Committee on School Construction.

**RCDD** - Registered Communications Distribution Designer. A certification program administered by BICSI which requires documented evidence of communications system design and/or installation experience, formal training, and successful completion of a certification examination. This certification can be supplemented with a LAN Specialty designation with further training and examination.

**Scalability** -The ability to expand the size and capabilities of a telecommunications infrastructure in a structured and modular fashion.

**SNMP** - Simple Network Management Protocol.

**Star Topology** - A physical topology in which each Work Area Telecommunications Outlet is wired directly to the main network distribution device (hub, concentrator). As required by these MSDE Standards, star topologies connect to distribution devices through a cross-connect. **See Topology and Part 4.1.3.**

**Switch** - For data systems, an electronic device which allows transmission signals on a single cable to connect to several destinations simultaneously.

**Tap -** A device, used to connect video backbone cable to the individual video outlet cables, which is designed to provide appropriate video signal balancing. The value of each tap must be carefully engineered in order to ensure correct balancing and operation of the system.

**TBB -** Telecommunications Bonding Backbone. **(See Part 6)**

**TBBIBC -** Telecommunications Backbone Interconnecting Bonding Conductor. **(See Part 6)**

**TC** - Telecommunications Closet.

**Technology in Maryland Schools -** A State funding initiative, administered by MSDE and the PSCP, to support telecommunications cabling infrastructure installation, equipment purchasing and staff development in technology.

**TEF -** Telecommunications Entrance Facility.

**Telecommunications -** For purposes of this MSDE Standard, voice, video and data communications systems used to support school instruction, administration, and building management.

**Telecommunications Closet (TC) -** A dedicated space which serves as a secondary "hub" for the distribution of telecommunications services to the work areas. One or more TC's may be required in school facilities utilizing a hierarchical star wiring topology. **See Part 3.6** for a detailed definition and requirements.

**Telecommunications Entrance Facility -** See Entrance Facility.

**Telecommunications Equipment Room (TER) -** A dedicated room which serves as the main "hub" for the distribution of all telecommunications services to the rest of the school facility. Each school facility which falls under the jurisdiction of this MSDE Standards is required to have a TER. (Referred to as the *Equipment Room* in the ANSI/EIA/TIA-568A Standard). **See Part 3.5** for a detailed definition and requirements.

**Telecommunications Industry Association (TIA) -** An international association which establishes industry standards for telecommunications infrastructure in partnership with the Electronic Industries Association (EIA). See **References.**

**Telecommunications Outlet (TO)** - A single connecting device which provides the interface between a work area equipment cable and a single horizontal cable. Several Telecommunications Outlets may be combined into one faceplate (See Drop). **See Part 4.2.**

**Telecommunications Pathways -** A building component that provides for the placement of telecommunications cable.

**Telecommunications Spaces** - Building spaces (rooms) designed to accommodate main telecommunications equipment exclusively, such as the Telecommunications Entrance Facility, the Telecommunications Equipment Room and Telecommunications Closets.
**TER** - Telecommunications Equipment Room.

**TGB** - Telecommunications Grounding Busbar. **(See Part 6)**

**TIA** - Telecommunications Industry Association. An international association which establishes industry standards for telecommunications infrastructure in partnership with the Electronic Industries Association (EIA). See **References.**

**TIMS** - Maryland's *Technology in Maryland Schools* funding initiative. This initiative provides funding, through the Maryland Public School Construction Program, for building telecommunications infrastructure such as cabling, electrical upgrades, and network connecting hardware and electronics. It also provides funding through direct grants for staff training and equipment.

**TMGB** - Telecommunications Main Grounding Busbar. **(See Part 6)**

**TO** - Telecommunications Outlet.

**Topology -** For purposes of this MSDE standard, topology refers to the physical hierarchy and layout of telecommunications cabling and equipment in the school facility. **See 4.1.3. and Part 5.**

**VCR -** Videocassette recorder.

**UL** - Underwriters Laboratories; See **References.**

**Unshielded Twisted Pair (UTP) -** A type of copper cabling media telecommunications wiring.

**UPS** - Uninterruptable Power Supply.

**UTP** - Unshielded Twisted Pair. A type of copper telecommunications cabling in which pairs of non-shielded insulated copper conductors are twisted around one another in order to reduce electrical noise such as crosstalk. The Enhanced Category 5 UTP specified in this MSDE standard contains a total of four-pairs of conductors.

**WAN** - Wide Area Network. Typically, a telecommunications network comprised of and linking a number of Local Area Networks.

**WLAN** - Wireless Local Area Network. A LAN implementation which utilizes infrared or radio transmission technology (in lieu of horizontal cabling) to connect individual work stations and/or entire work areas to a Local Area Network. For a detailed definition and requirements. **See 4.10.3.**

**Work Area** - For purposes of this MSDE standard, any area in a school facility containing Telecommunications Outlets for connecting telecommunications devices to a building-wide network. This includes, but is not limited to, teaching spaces of all types, administrative areas, and large mechanical, electrical and storage rooms.

# References

The following documents have been referenced in, or are related to, this MSDE Standard and are valuable resources. The web sites of many of the standards organizations can provide useful insight into activities regarding standards which are currently under development. Contact information is subject to change.

**TIA/EIA STANDARDS**

| | |
|---|---|
| **TIA/EIA-568A** | *Commercial Building Telecommunications Cabling Standard* |
| **TIA/EIA-569A** | *Commercial Building Standard for Telecommunications Pathways and Spaces* |
| **TIA/EIA-492AAAA** | *Detail Specification for 62.5 Micrometer core diameter/125 Micrometer cladding diameter Class1a Multimode, Graded Index Optical Waveguide Fibers* |
| **TIA/EIA-606** | *Administration Standard for the Telecommunications Infrastructure of Commercial Buildings* |
| **TIA/EIA-607** | *Commercial Building Grounding and Bonding Requirements for Telecommunications* |
| **TIA/EIA TSB 67** | *Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems* |
| **TIA/EIA TSB 72** | *Technical Services Bulletin - Centralized Optical-Fiber Cabling Guidelines* |
| **TIA/EIA TSB 75** | *Technical Systems Bulletin - Additional Horizontal Cabling Practices for Open Offices* |
| **TIA/EIA SP-4195** | *Proposed Addendum No. 5 to TIA/EIA-568A: Additional Transmission Performance Specifications for 4-pair 100 Ohm Enhanced Category 5 cabling (latest edition).* |

TIA/EIA Standards are available through Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112-5704 Phone: 800-854-7179 Fax: 303-397-2740
http://global.ihs.com/ e-mail: global@ihs.com

**ADAAG,** *The Americans with Disabilities Act Accessibility Guidelines*
United States Architectural and Transportation Barriers Compliance Board (Access Board)
For assistance or for obtaining documents telephone: (202) 272-5434 or (800) 872-2253
online: http://www.access-board.gov or at Maryland Code Lynx: http://lhi5.umbc.edu/dhcd/

**ANSI/NFPA 70,** *National Electrical Code*
National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101
(617) 770-3000 Customer Services Order: (800) 344-3555 TDD (617) 984-8770
http://roproc.nfpa.org

**ASTM E 814,** *Fire Tests of Through-Penetration Firestops*
American Society for Testing and Materials, 100 Bar Harbor Drive, West Conshohocken, PA
19428-2959

**BICSI,** *Telecommunications Distribution Methods Manual (TDMM)*
Building Industry Consulting Service International, 8610 Hidden River Pkwy, Tampa, FL 33637
http://www.bicsi.org/ Tel: (800) 242-7405 Fax: 813 971-4311

**BICSI,** *LAN Manual*
Building Industry Consulting Service International

**BICSI,** *Cabling Installation Manual*
Building Industry Consulting Service International

**BOCA,** *The BOCA National Building Code*
Building Officials & Code Administrators International, Inc., 4051 W. Flossmoor Rd.., Country Club
Hills, IL 60478-5795 Tel: (708) 799-2300 Fax: (708) 799-4981 e-mail: info@bocai.org

**COMAR 05.02.02,** *Maryland Accessibility Code*
See the complete code online through the Maryland Code Lynx homepage at:
http://lhi5.umbc.edu/dhcd/

**FCC 47 CFR 68**, *The Code of Federal Regulations* (Latest Revision)
Federal Communications Commission, Washington, D.C. 20554
Telephone: (301) 725-1585 Online: http://www.fcc.gov/

**IEEE 802.3,** *CSMA/CD Access Method - Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications* (Ethernet Standards)
Institute of Electrical and Electronic Engineers, 445 Hoes Lane, P.O. Box 1331,
Piscataway, New Jersey 08855-1331, (732) 981-0060 or (800) 678-IEEE (U.S. only)
http://standards.ieee.org/

**IEEE 802.7,** Recommended Practices for Broadband Local Area Networks
Institute of Electrical and Electronic Engineers

**IEEE 802.11**, *IEEE Standard for Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications* Institute of Electrical and Electronic Engineers

**IEEE 1100-1992,** *Recommended Practice for Powering and Grounding Sensitive Electronic Equipment* Institute of Electrical and Electronic Engineers

**Maryland Plan for Technology in Education 1999-2003,**
Maryland State Department of Education 200 W. Baltimore Street, Baltimore, MD 21201
Telephone: (410) 767-0382 TTY/TDD: (410) 333-6442 www.msde.state.md.us or
The Maryland Business Roundtable for Education, 111 S. Calvert Street, Suite 1720
Baltimore, MD 21202 Telephone: (410) 727-0448 e-mail: mbrt@clark.net

**MBPS**, *Maryland Building Performance Standards* (Statewide Building Codes incorporating BOCA with State and Local Amendments)
Department of Housing and Community Development, Maryland Codes Administration
100 Community Place, Crownesville, MD 21032-2023
Telephone: (410) 514-7255 TTY: (410) 514-7531
Or see the Maryland Code Lynx homepage at: http://lhi5.umbc.edu/dhcd/

**NFPA 101**, *Life Safety Code*
National Fire Protection Association

**NFPA 780**, *Lightning Protection Code*
National Fire Protection Association

**SCTE#IPS-SP-001,** Flexible RF Coaxial Dropcable Specification
Society of Cable Television Engineers, Inc. 669 Exton Commons, Exton PA 19380

**Telecommunications Industry Association**, 2500 Wilson Boulevard, Suite 300, Arlington, VA 22201
Telephone: (703) 907-7700 Fax: (703) 907-7727 TTY: (703) 907-7776

**UL 910,** *Test for Flame Propagation and Smoke Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air*
Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook IL 60062
www.ul.com

**UL 1479**, *Fire Tests of Through-Penetration Firestops*
Underwriters Laboratories, Inc.

**UL Fire Resistance Directory**, *Volumes 1 and 2*
Underwriters Laboratories, Inc.

# Appendices

Appendix A - Minimum Quantity of Telecommunications Outlets

Appendix B - Summary of Minimum Telecommunications Wiring Standards

Appendix C - Technology Capabilities

Appendix D - Standards-Based Infrastructure Design

# Appendix A

## Minimum Quantity of Telecommunications Outlets [1]

| Space | Telecommunications Outlet Capabilities and Quantities | | |
|---|---|---|---|
| | Data [2] | Voice | Video |
| Classrooms<br><br>Includes all instructional areas noted below. | 3 Student Workstation Outlets<br><br>1 Teacher Workstation Outlet<br><br>1 Optional-use networked device outlet (Workstation, printer, scanner, etc.) | 1 | 2<br><br>(High-low configuration - See Part 5.5) |
| Key Administrative Offices (Principal, V.P., Guidance, etc.) | 1 Per Occupant + additional outlets for networked devices as required | 1 | 1 |
| All Other Offices, Administrative Spaces | 1 Per Occupant + additional outlets for networked devices as required | 1 | - |
| Teacher Planning Rooms | 1 Per Workstation (2 minimum) | 1 | 1 |
| Conference Rooms | 1 | 1 | 1 |
| Instructional Media Center | 1 for each 4 students of room capacity. (Room capacity calculation = 8% of enrollment up to a maximum of 125)<br>1 networked device outlet for each 5 student outlets.<br><br>2 outlets per staff workstation | 1 | 1 |
| Computer Laboratories | 1 Per Student Workstation<br><br>1 Teacher Workstation Outlet<br><br>1 Networked device outlet for each 5 student outlets (4 minimum) | 1 | 2<br><br>(High-low configuration - See Part 5.5) |
| Special Subject Laboratories (i.e., Science, Technology Ed, Family and Consumer Sciences) and Art Rooms | 1 Per Group Workstation, but not less than 1 per 4 students.<br>2 additional network device outlets.<br><br>1 Teacher Workstation Outlet | 1 | 1 |
| Gymnasiums (including all auxillary P.E. instructional spaces) | 1 | 1 | 1 |
| Multi-Purpose Room/ Cafetorium | 1 | 1 | 1 |
| Food Service Point of Sale | 1 Per Serving Line | - | - |
| Stage (Elementary Schools) | 1 | 1 | 1 |
| Stage (Secondary Schools) | 1 | 1 | 2 |
| Storage Rooms >/= 100 nsf | 1 | 1 | - |
| Telecommunications Equipment Rooms<br>Telecommunications Closets<br>Electrical Service Entrance Facility<br>Mechanical Equipment Rooms >100 sf | 1 | 1 | - |

(1) Telecommunications outlets shall be provided in all instructional, administrative, and support spaces except toilet rooms, janitors closets, small storage rooms, etc. Additional optional-use outlets for networked devices (i.e., workstations fax, printers, scanners, plotters, etc.) shall be provided where required. Designers are cautioned to not overlook small support spaces such as music practice rooms, special education observation rooms, school store, control rooms, etc.

(2) In the presence of Wireless Local Area Network (WLAN) capability, a minimum of 1 hardwired data outlet per space shall be provided for additional networked devices, in addition to required voice and video outlets. (See Part 4.10.3).



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# Appendix B

## Summary of Minimum Telecommunications Wiring Standards

| COMPONENT | ITEM | REFERENCE | DATA | VOICE | VIDEO |
|---|---|---|---|---|---|
| Work Area | **Quantity** | Appendix A/4.2.1 | Figure 2.1 | Figure 2.1 | Figure 2.1 |
| | **Connector** | 4.2.2 | 8-Position (RJ-45) | 8-Position (RJ-45) | "F+G" Type |
| Telecommunications Outlets (TO) | **Pin-Pair Assignments** | 4.2.2 | EIA/TIA T568A (568B Optional) | EIA/TIA T568A (568B Optional) | N/A |
| | **Configuration** | 4.2.1 | Min. 2 outlets per drop (i.e. 2 data or 1 data + 1 voice, etc.) | Min. 2 outlets per drop (i.e. 2 data or 1 data + 1 voice, etc.) | As Required |
| Work Area Power Outlets | **Quantity** | 6.6 | (1) Duplex Outlet per video Outlet | (1) Duplex Outlet per voice Outlet | (1) Duplex Outlet per video Outlet |
| | **Circuiting** | 6.7 | 20 AMP 120V, 1 phase circuit, max. (4) duplex receptacles per circuit | | |
| Horizontal Distribution | **Cable** | 4.3.2 | Enhanced Category 5 UTP | Enhanced Category 5 UTP | RG-6/u Coaxial |
| | **Conductors** | 4.3.2 | 4 Pair (8 conductor) | 4 Pair (8 conductor) | Single |
| | **Rating** | 4.3.2 | Plenum rated where required by code | | |
| | **Pathways** | 3.2 | Conduit from outlet to ceiling | Conduit from outlet to ceiling | Conduit from outlet to ceiling |
| Connecting Hardware | **Patching Connector** | 4.3.4/4.4.6 | RJ - 45 | RJ - 45 | BNC Type (Type "F" Alt.) |
| | **Punch Down** | 4.3.4/4.4.6 | 110 Type | 110 Type | N/A |
| | **Patch Cables** | 4.3.4/4.4.6 | Enhanced Category 5 UTP | Category 3 UTP | Part 5 |
| Backbone Distribution (Intra-building) | **Cable** | 4.4.2 | Multi-mode fiber optic | Category 3 UTP | RG-11/u 500 Series Alternate) |
| | **Conductor** | 4.4.2/4.4.5 | 12 Strand | High-Pair Count (25+) | Single |
| | **Rating** | 4.4.2 | Plenum rated where required by code | | |
| | **Connector** | 4.4.6 | 568 SC or Small Form Factor (SFF) | Category 3 Block | BNC Type |
| | **Pathways** | 4.4.1 | Conduit/Tray/Innerduct | | |
| | **Riser Cable** | 4.4.1 | Plenum rated | | |
| Campus Backbone Distribution (Inter-building) | **Cable** | 4.4.1/4.4.2 | Multi-mode fiber optic | Category 5 Enhanced UTP | RG-11/u 500 Series |
| | **Conductor** | 4.4.1/4.4.2 | 12 Strand | High-Pair Count (25+) | Single |
| | **Connector** | 4.4.6 | 568 SC | Category 5 Block | BNC Type/(FAlt) |
| | **Pathways** | 3.4 | Overhead or conduit - (direct burial not acceptable) | | |



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# Appendix C - Technology Capabilities

***The following is provided for informational purposes only, and does not form a part of this Standard.***

**A. Accommodated Technologies**

It is anticipated that by providing their school facilities with Telecommunications Distribution Systems which are in compliance with these Standards, Local School Systems will have the basic infrastructure to accommodate the technologies outlined on the following pages.

**Note:** Most of these Technology Capabilities require the installation of equipment and software, or the application of protocols, which extend beyond the scope of these Standards. Therefore, actual implementation and use of these capabilities in a particular school is a decision of the Local School System. This decision must be in alignment with local Board of Education policies, educational methods, security and confidentiality protocols, budget, and the availability of supporting equipment and trained personnel.

Several of these capabilities are required in order to meet the minimum objectives outlined in The Maryland Plan for Technology in Education (MPTE). For example: Items 2a, 2b and 6 below are specifically mentioned in Objective No. 1 of the MPTE - "Ensure Access for All Learners". Items 2d and 2g are mentioned in Objective No.2 of the MPTE - "Integrate Technology into all aspects of the school system." These capabilities should be given high priority in the implementation of school information technology systems.

**B. Technology Capabilities supported by these Standards**

The following list is a sample of predominant technologies which are being incorporated into public school facilities nationally, and which can be supported by implementation of these MSDE Standards with the provision of additional software and equipment:

**1. Data Network Capabilities**

**a.)** Building-wide Local Area Networks (LAN) and the capability for connecting the LAN to a regional Wide Area Network (WAN) are supported.

***i.)*** These MSDE Standards support implementation of the following existing and proposed IEEE Network Control Standards requiring up to 100 MHZ of bandwidth to the desktop.

| | |
|---|---|
| 10Base-T Ethernet | (10 MHZ) |
| 100Base-T Ethernet | (62.5 MHZ) |
| 1000Mbps Ethernet | (62.5 MHZ) *Proposed standard* |
| 155 Mbps ATM | (77.5 MHZ) |

***ii.)*** In addition to the above network control standards, the distribution systems outlined in this document also support implementation of the following additional network control standards across the backbone:

Fiber Distributed Data Interface (FDDI)
Asynchronous Transfer Mode (ATM)
Fiber-based Ethernet Standards

**b.)** High capacity (i.e., full graphics, sound, and video) Internet access from all classroom/instructional and administrative support areas is supported.

**c.)** Access to Internet-based or other LAN/WAN based remote energy-use monitoring systems from mechanical rooms and electrical service entrance facilities is supported.

**d.)** Access to instructional and administrative information resources on central file servers from all classroom/instructional and administrative support areas through a LAN is supported.

**e.)** Infrastructure support is provided for full building-wide Network Management to the individual Telecommunications Outlets (e.g., on-line trouble shooting for networks or workstations from a central point within the school). The capability for Network Management from locations outside the building (i.e., a central office), is not precluded by these Standards.

**f.)** The provision of desktop-based video-conferencing over the LAN and Internet is supported by telecommunications distribution systems which are compliant with these Standards.

**g.)** Library Media Center Resources:

***i.)*** Access to Library Media Center information resources (e.g., CD's, databases) from all classrooms/instructional and administrative areas through the LAN is supported by these Standards. With the provision of additional equipment, and the implementation of appropriate security protocols, these same resources could become available from the home, other schools, and the Public Library.

***ii.)*** Access to Media Center automated cataloging and circulation system from all classrooms/instructional and administrative areas through the LAN is supported.

**h.)** E-Mail

***i.)*** Communications capability via computer-based electronic mail (E-mail) from all classrooms, instructional and administrative areas within the school building and with locations outside the school is supported.

**2. Voice Communications**

**a.)** Support for two-way voice communication (telephone) from all classroom/ instructional and administrative areas is provided.

**b.)** Access to Voice Messaging resources (voice mail, general information, bulletins, etc.) from classrooms/instructional and administrative areas and from locations outside the school are not precluded by adherence to these Standards.

**c.)** Public address system capability, with access to all classroom/instructional areas and administrative support areas, is not precluded by adherence to these Standards.

**3. Video**

**a.)** Telecommunications distribution systems installed in accordance with these Standards support bi-directional video capability in all classroom/instructional and conference areas, and in selected administrative areas, allowing each of these spaces to become either the originating source, or the recipient of, video programming with the provision of appropriate equipment.

**b.)** Access from all classroom/instructional and conference areas to a variety of external video sources (e.g., cable, satellite, microwave etc.) from a centralized distribution point within the building and/or school system is supported by these Standards.

**4. Facsimile Transmission**

**a.)** Support for the transmission of fax technology from all classroom/instructional areas and administrative support areas, either over the data LAN or the voice infrastructure, is provided.

**5. Accessibility**

**a.)** Work Area telecommunications equipment, capable of providing telecommunications accessibility to individuals with disabilities as required by applicable Federal, State and Local codes and regulations, is supported by telecommunications distribution systems installed in accordance with these standards.

# Appendix D - Standards-based Infrastructure

***The following is provided for informational purposes only, and does not form a part of this MSDE Standard.***

As previously discussed, this document emphasizes the need for implementing a technology infrastructure in each of Maryland's Public School's which is based on widely-recognized industry standards. The following is a brief discussion of some of the advantages, and some of the cautions, with this approach.

**A. Standards based systems - Advantages:** The telecommunications distribution system standards discussed in **Part 4** describe a structured cabling system based on nationally recognized industry standards. The advantages of such an approach to telecommunications distribution are numerous, but include the following system characteristics:

***i.)*** Predictability of performance based on widely recognized performance criteria.

***ii.)*** High reliability.

***iii.)*** Flexible systems designed to accommodate Move-Add-Change management over the long-term.

***iv.)*** Ease of system management and maintenance due to the accommodation of central system management protocols and through the use of standards-based installation techniques, components and identification schemes.

***v.)*** Ease of system installation, management and maintenance through the use of systems having the largest network of trained installers and technicians. The vast majority of telecommunications design and installation training is based on the implementation of the ANSI/EIA/TIA standards.

***vi.)*** Assurance of long-term component compatibility by the use of standards-compliant equipment. The vast majority of manufacturers are producing equipment and components based on the current ANSI/EIA/TIA standards. Future innovations will evolve to provide logical upgrade paths based on the currently installed infrastructure base.

***vii.)*** The accommodation of numerous existing and "under-development" technologies, allowing a structured migration path to faster network control standards (up to 1000Mb/s to the Telecommunications Outlet for data as of this writing) as facility needs change.

**B. Standards-based systems - Limitations:** While it is believed that telecommunications distribution systems implemented in accordance with this MSDE document will have the ability to serve the needs of Maryland's public schools for many years to come, this document also recognizes two of the difficulties with utilizing a Standards-based approach, as follows:

***i.)*** Industry-standards are only comprehensively updated on an approximately five (5) year cycle. In order to keep them current, a series of Technical Service Bulletins or Addenda are issued as needs dictate. These amendments first require a necessary but time-consuming ratification process in order to achieve industry-wide acceptance. In an age of rapidly changing technology, this can somewhat delay the implementation of some "current best thinking" in terms of installation practices or new technology. Ultimately though, it is in the best interest of the consumer to wait until industry standards are ratified to avoid the potentially costly pitfalls associated with the installation of non-compliant systems.

***ii.)*** Standards-based techniques do not always address some of the unique situations sometimes encountered in the management of educational facilities, nor do they adequately cover all the telecommunications technologies currently in use. For example, EIA/TIA-568A does not thoroughly discuss the implementation of coaxial cable systems commonly utilized for the support of video and other broadband technologies. For these issues it is necessary to look beyond the most widely recognized standards to other standards used for specific industries (such as for cable television), to review applicable government requirements (such as FCC regulations), and to solicit the informed opinions of the most knowledgeable industry experts.

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